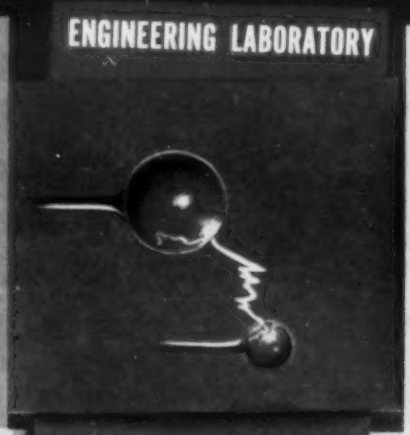

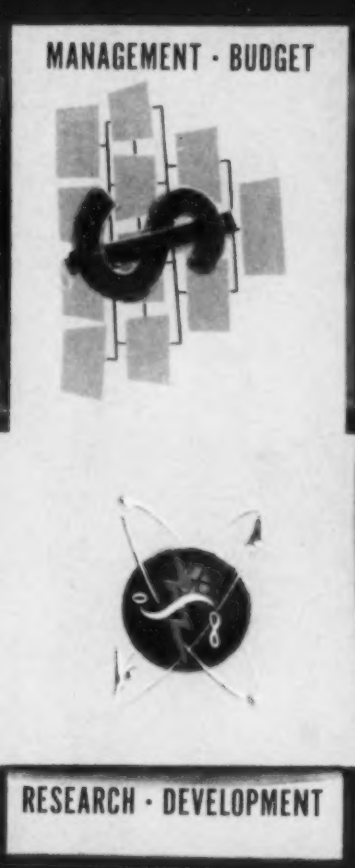

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McGRAW-HILL MAGAZINE OF DESIGN RESEARCH AND DEVELOPMENT

Product Engineering

DESIGN issue

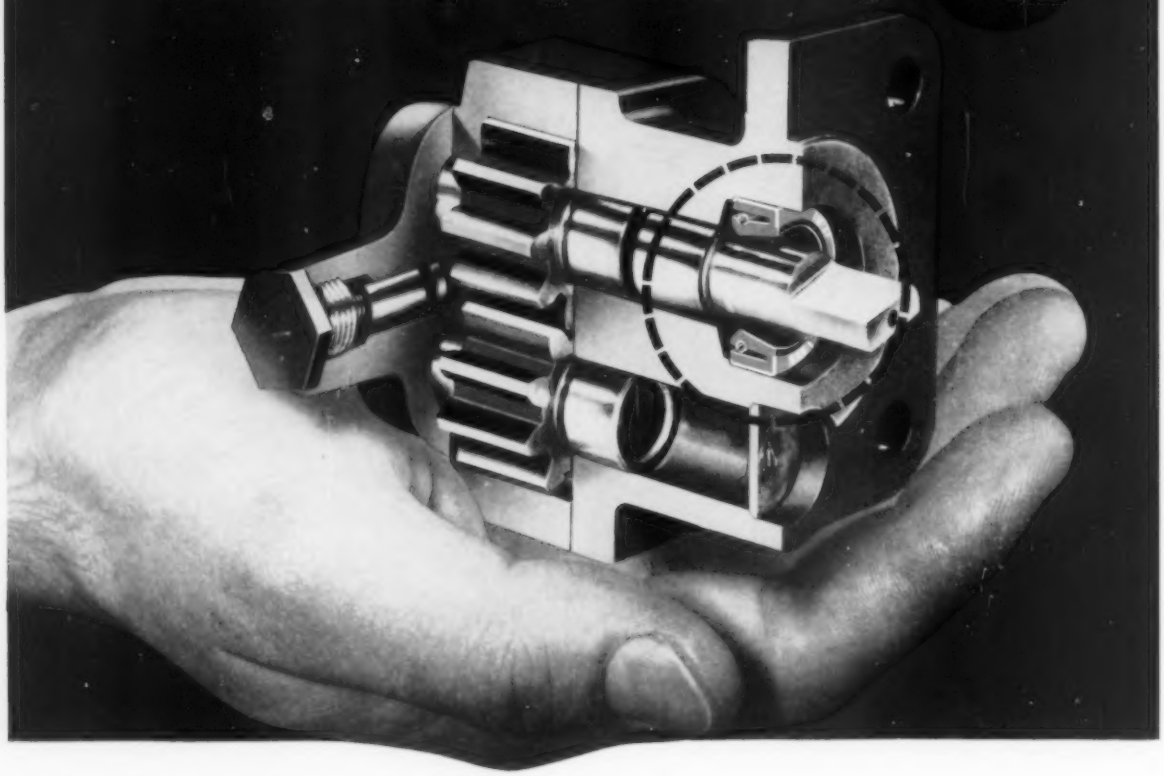
PLAN '59

Modernize now for growth and profits

A SPECIAL REPORT FROM McGRAW-HILL TO AMERICA'S BUSINESS EXECUTIVES

As part of a broad McGraw-Hill program, Product Engineering presents two special reports.
The second, "HOW to Modernize," is in this issue, the first, "WHY Modernize," appeared Oct. 6.

Champion performance in a fist-sized pump...sealed by C/R



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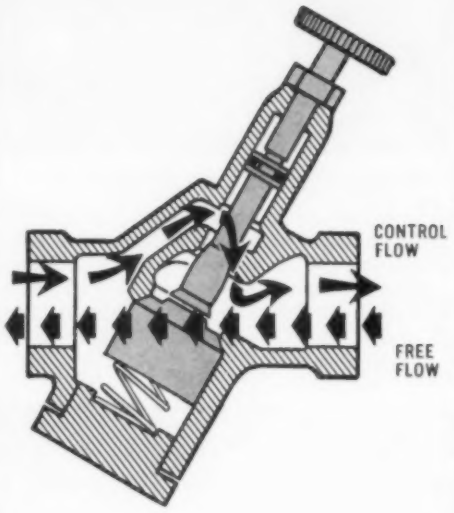

FREE FLOW TO CYLINDER (LEFT)
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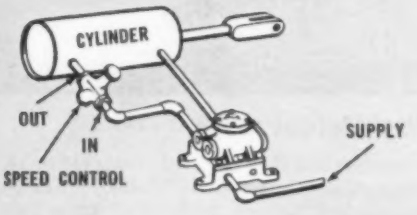

The speed control valve as used between a 4 way valve and a cylinder, shown above, regulates (slows down) the piston rod retraction.

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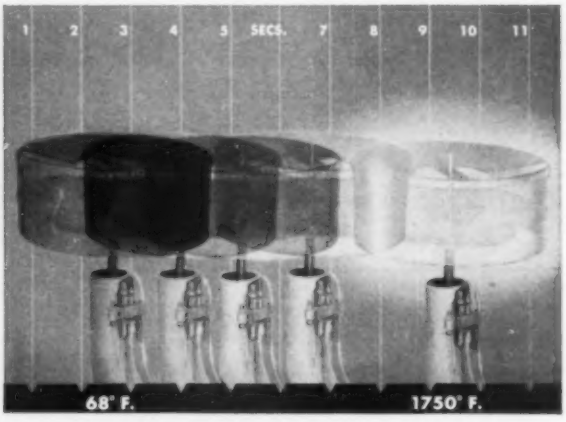

For cyclical thermal shock

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INCO NICKEL ALLOYS

Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

OCTOBER 13, 1958 Vol. 29, No. 42

SPECIAL REPORT

PLAN '59 . . . How to Modernize Now

Tomorrow's opportunity is knocking at the doors of your design office today. The Oct. 6 issue told why to modernize if your product-planning is to stay in the competitive race. This second report tells where and how you can replace obsolete facilities with what's new and efficient.

How Modern Is American Industry? **61** . . . McGraw-Hill Department of Economics
The challenge—your part in the $95 billion modernization job.

How to Modernize Engineering **65** . . . E J Tangerman, Chief Editor
A rundown on ways to get more effective working time.

For a Better Engineering Laboratory **66** . . . R W Carson, Managing Editor
Survey covers what a testing setup needs to stay in the race.

Modern Tools for the Draftsman **68** . . . Nicholas Chironis, Associate Editor
The latest on drafting tables and machines, microfilm, computers.

More Service from a Company Library **72** . . . Ruth Hibbert and R C May, Automatic Switch Co
A guide to how even the small library can handle bigger jobs.

When Model Shops Pay Off **74** . . . W E Boggs
Survey shows how they'll give cleaner design at less cost.

● ● ●

Another Way to Differentiate Curves **77** . . . B W Shaffer, NYU; Irvin Krause, City College of New York
Finite-differences method is more accurate than graphical way.

Design Features in New Products **80** . . . It's already 1959 in Detroit—engineering changes in the new Chryslers, Pontiacs, Cadillacs; supercharger gives peak power at right time; paper-thin stainless for heat exchanger.

Slip Casting . . . Its Field Broadens **84** . . . L M Schiffetli Jr, Haynes Stellite Co
The slurry method has now moved into the powdered-metal field.

When Choosing the Right Motor **86** . . . F D Yeaple Jr, Associate Editor
Bibliography of articles giving design guidance for any application.

Name Plates for Prototypes **88** . . . W R MacKinnon, Hughes Aircraft Co
Cheap, quick method uses sensitized sheet of anodized metal.

DESIGN FILE

14 Special-purpose Bearings **96** . . . Federico Strasser, Mankowitz & Strasser Ltd
Helpful hints in bearing design for round, revolving shafts.

The Right Finishes for Stainless Steel **99** . . . R E Paret, American Iron and Steel Institute
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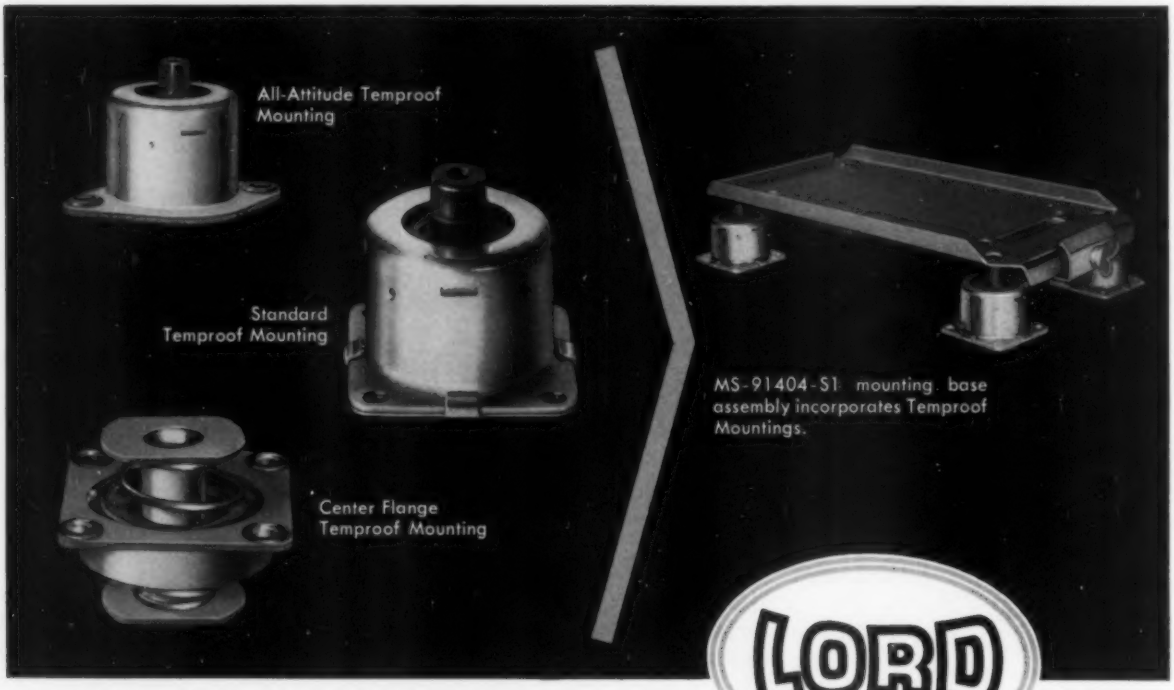
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Interesting to Note . . .

Plan '59—Modernization

All too often the word "modern" is enough to either attract a customer or scare him away. For example, take the traveling dentist of Western fame. He drove a covered buckboard which served as his home and office. On the side a large placard read: "Dr. I. M. Pullman—Dentist . . . Teeth Pulled the Modern Way." Here, "modern" was a come-on. It promised that the dentist would use a general anesthetic—such pain-killers were just coming into prominence.

On the other hand, "modern", when applied to music, art and certain aspects of literature, can imply a false meaning, the abstract—and repel people who prefer Grandma Moses.

This issue of PRODUCT ENGINEERING, like all current McGraw-Hill magazines, is devoting a segment of its editorial content to the vital challenge facing American industry—modernization. Here the question, "How Modern Is American Industry?" is answered concisely and frankly (see p. 61). A report by the McGraw-Hill Department of Economics states bluntly that, "The production and distribution facilities of the USA are not efficient enough to ensure our continuing superiority over the Communist world. . . ."

The point is that we have enough capacity to meet current needs, but that too high a proportion of this capacity is outdated, obsolescent, so it costs too much to use. This comment can apply to engineering equipment and even engineering thinking just as it does to production units. What we have tried to do is to provide some ideas of recent developments and trends in engineering department operations. Last week (Oct 6) we presented eight pages on the "why" of modernization; herewith we conclude with 16 pages of "how" data. Both are broader in content than just the design room; they include engineering laboratory, model shop, library, and R & D department as well.

A Light in the Dark

Martin Johnson, the late African explorer, told an interesting story of man's meeting machine. After driving miles into the Kenya bush country one day in the early 1930s, Johnson's party spotted a village. Fortunately, the natives showed friendly interest in the strange caravan of lorries that was growling outside their homes. They had seen white men in motor cars before but never had a herd of them been so close to their town.

(Continued on page 7)

Product Engineering
A McGRAW-HILL PUBLICATION

OCTOBER 13, 1958 Vol. 29, No. 42

PRODUCT ENGINEERING is published weekly, with an additional Design Digest Issue in Mid-September, by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. PUBLICATION OFFICE, 99-129 North Broadway, Albany 1, N. Y. See panel right for directions regarding subscription or change of address. EXECUTIVE, EDITORIAL, CIRCULATION and ADVERTISING OFFICES: 330 W. 42nd St., New York 36, N. Y.

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PRODUCT ENGINEERING articles are indexed in both the **Industrial Arts Index** and the **Engineering Index**. PRODUCT ENGINEERING publishes its own semi-annual index including the Design Digest Issue. Copies are obtainable on request to the Editor.

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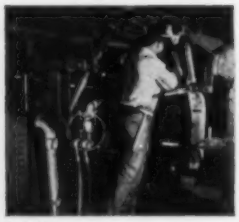

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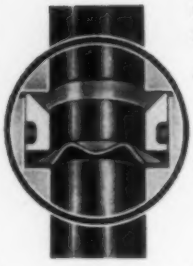

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Interesting to Note . . . . *(continued)*

At night, one of the young men had enough curiosity and courage to actually climb into the cab of a truck and examine the panel. He made the mistake of pulling the headlight switch. This sent weird beams of light through the darkness, alarming the entire village and panicking the boy. As he made a hurried exit from the truck his hand hit the horn button and a loud "honk" added to the confusion. By this time the villagers were sure one of them was being consumed by the steel monster that sees in the dark. Fortunately, Johnson got to the headlight fast and shut it off, preventing what might have been a disastrous end to the safari.

Electric motors (p. 86) and machines have puzzled people for centuries. King Louis XV once had 180 soldiers grasp hands, then had one of them touch a Leyden jar. Why? The French king wanted to see his soldiers jump in unison. Early electrical experiments of this type have long amused people. When Parisians heard of their king's interest in electricity they arranged to have 700 Carthusian monks stand in a row, then simultaneously jump into the air on being shocked. The Russian professor Georg Richman tried demonstrating Franklin's kite experiment in 1753. His equipment wasn't grounded and a bolt of lightning killed him. If it was any consolation: He became the first martyr to give his life for the new electrical science.

England's Henry Ford

After a sumptuous dinner at his London home, Sir William Lyons will retire to his library where his butler will have brandy and coffee waiting. Instead of reading the evening paper or a detective story, Sir William will pick up a handful of clay and begin molding. When he's through he has a clay model of an automobile. If he likes it, it will be cast in plaster and placed next to hundreds of others in his home. Should he be overly enthused with it, he'll take it to his office in Coventry. Sir William is chairman and Managing Director of Jaguar Cars Ltd and is in effect, Mr. Jaguar.

Since the death of Henry Ford in 1947 just about every major automobile company has been run by committees; the day of the auto entrepreneur died with Ford. The only exception is perhaps Sir William Lyons. With William Walmerley, he co-founded the Swallow Sidecar Co in 1922. Twenty-three years and several mergers later, the name was changed to Jaguar Cars Ltd, with Lyons running the entire show. The name Jaguar was chosen from a list of 500 fish, flesh and fowl to represent Lyons' "new look" of 1935. When the "SS Jaguar" was unveiled, it sold for $1900—success was immediate; Lyons could write orders for more cars than he could produce.

Most of Jaguar's design work is suggested by Lyons. By using models (p. 74) he will get an idea, then literally mold it into a finished style. The 15 company executives all are directly answerable to Lyons, making this probably the last monarchical setup in the auto business.

Lyons, who was knighted in 1956, wants to go on producing a first-class prestige car. The product is considered before the profit. When, for example, Sir William saw a plane make an abrupt stop on an English landing strip, he asked an engineer, "What kind of brakes does that chap have?" "It's something new," replied the engineer, "a disk-type of brake." Lyons liked the idea, wanted such brakes, got them. They were tried experimentally in 1949 and fitted on "Jag" racers three years later; now they're standard on all model Jaguars. "What if they're more expensive?" says Lyons. "They make for a better car."

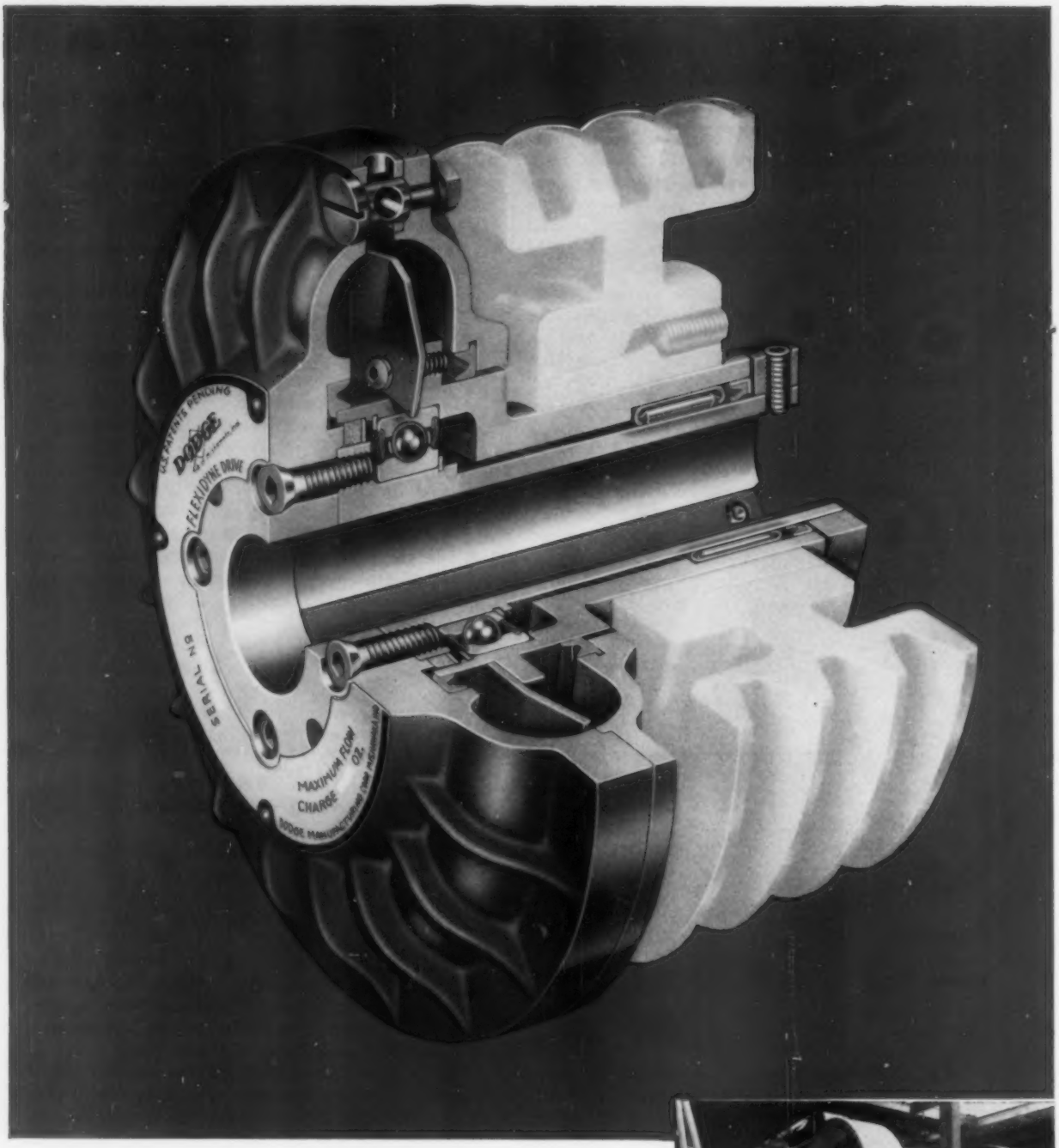
Jaguar doesn't have yearly model changes as do the US cars described on page 80. In fact, with limited production, only about 30,000 "Jags" of all vintages were on American roads in 1958—Detroit can turn out this number in less than a week.

Sewing with Stainless

All too often a scientist has to take drastic personal measures to prove a point. There is the story of Dr. Walter Reed who wanted to place his arm into a glass cage containing several aëdes mosquitos to prove a theory that they transmitted yellow fever. Fortunately his associates talked him out of the idea. And in order for Edward Jenner to convince people that he had discovered a way to prevent smallpox from completely ravaging Europe in 1796, he first had to take the risk of trying his untried "vaccine"on an 8-year-old boy.

There are still those who find that the only way to prove a point is to use a human guinea pig. Thirty years ago, a Philadelphia surgeon, Dr. W. Wayne Babcock, wanted to find a better suture. He found that catgut (actually made from sheep intestines) had a tendency to weaken and even cause infection. Then, at a Rotary Club luncheon, he happened to sit next to a man from a steel company. In the course of their conversation the steel man mentioned the many advantages of stainless steel (p. 99). This germ of an idea was all Dr. Babcock needed. He went on to test stainless wire sutures on animals and then dramatically demonstrated his belief in stainless stitches several years ago when he insisted they be used in a cataract operation performed on his own eye. Today, thanks to Dr. Babcock, stainless sutures are available at nearly every major hospital.

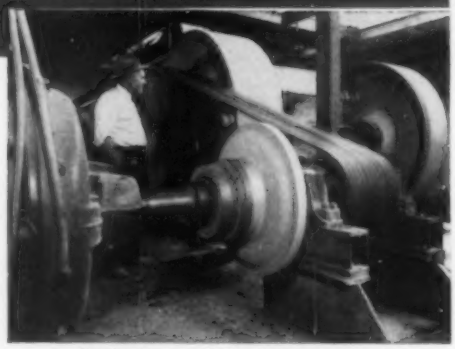
—Benedict A. Leerburger Jr.



HOW FLEXIDYNE WORKS

The "dry fluid" in Flexidyne is tiny heat-treated steel shot. A measured amount, called the "flow charge," is contained in the housing, which is keyed to the motor shaft. Inside the housing is a rotor, free to revolve relative to the housing, but connected to the load.

When the motor is started, centrifugal force throws the flow charge to the perimeter of the housing, packing it between the housing and the rotor, which transmits power to the load. Initial slippage is momentary. Housing and rotor become locked together and achieve full load speed without slip and at 100% efficiency.



Overloads on a 150 hp jaw crusher cause sudden damage. Here Flexidyne is used to minimize this costly trouble. As a bonus, it reduces belt wear and replacement.

FLEXIDYNE

THE DRY FLUID DRIVE

OFFERS A NEW APPROACH TO DIFFICULT DRIVE PROBLEMS...OPENS THE WAY TO MULTIPLE SAVINGS!

IT IS NO LONGER NECESSARY to accept the destructiveness—the costliness — of conventional starting in the mechanical transmission of power! Flexidyne changes that.

LOOK AT YOUR DRIVES! Are you using expensive oversize or high torque motors merely to get your loads started? Are you using expensive starting equipment? Are you tolerating high demand rate? Are your belt maintenance costs high, because of the shock of across-the-line starting?

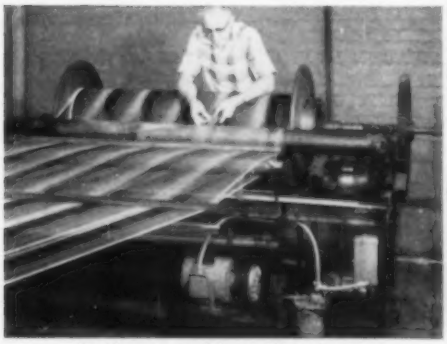
HOW ABOUT THE MATERIAL YOU PROCESS—wire, paper, textiles? Is your output hampered by breakages that you accept as "normal production"? Do you burn up clutches in getting your loads up to speed?

FLEXIDYNE—THE DRY-FLUID DRIVE—solves these problems—and many more! Flexidyne is revolutionary. *And so simple!* Off the shelf availability. Drives or Couplings. Fractional to 1000 hp. Ask your local Dodge Distributor or write us for technical Bulletin.

DODGE MANUFACTURING CORPORATION, 1200 Union St., Mishawaka, Ind.

CALL THE TRANSMISSIONEER
—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

DODGE
of Mishawaka, Ind.



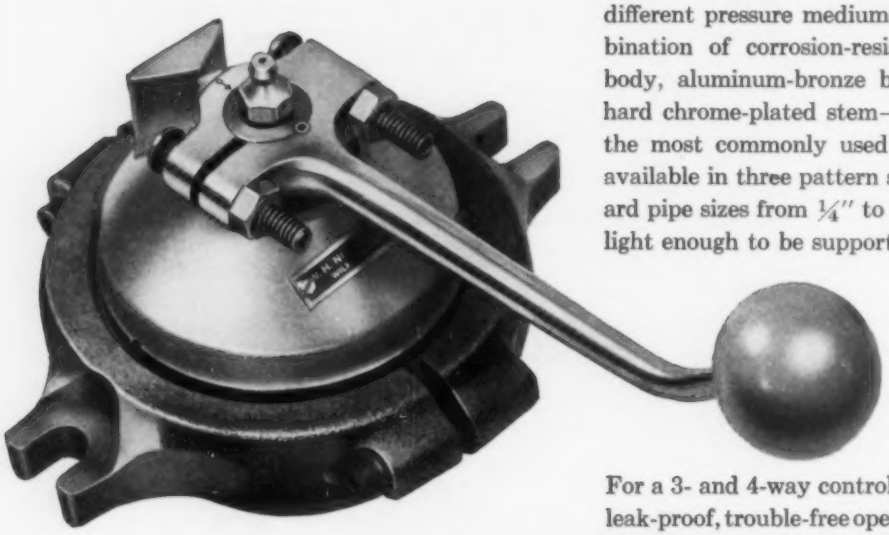
Flexidyne, accurately set for extra gentle starting, solves the problem of thread breakage on this textile beam warper—vastly multiplying productivity.

Smooth starting and deft spotting are required with this 20-ton crane. Flexidyne accomplishes both—and by so doing saved $4,000 in electric controls!

A ball mill drive is a tough one. Flexidyne not only eases heavy starting shocks here but eliminates the necessity *and the cost* of an oversize motor!

Here's a control valve that assures you

leak-proof service



Highly-lapped metal-to-metal surfaces of this Nicholson control valve assure you leak-proof service. The O-ring stem packing and O-ring seal between the body and base make joints leak-proof without excessive bolt tension.

You can use the Model 300 with air, water, hydraulic fluid or oil as the pressure medium . . . at operating pressures to 300 psi. Use it to activate single- or double-acting cylinders. Simple and rugged, this valve provides accurate, repeatable control of equipment such as presses, hoists, clutches and chucks. Valve maintenance is no problem . . . all stem, base and disc bearing surfaces are lubricated through one easily accessible fitting on top of valve stem. Lubricant reservoir in base reduces frequency of lubrication.

No need to stock valves or parts for service with different pressure mediums. This valve's *one* combination of corrosion-resistant materials—bronze body, aluminum-bronze base, stainless-steel disc, hard chrome-plated stem—is well suited for all of the most commonly used pressure mediums. It's available in three pattern sizes covering five standard pipe sizes from ¼" to 1" . . . small enough and light enough to be supported by connected piping.

For a 3- and 4-way control valve that will give you leak-proof, trouble-free operation, specify Nicholson. W. H. NICHOLSON AND COMPANY, 14 OREGON ST., WILKES-BARRE, PA. Sales and Engineering Offices in 98 principal cities.

Write for Bulletin 300 . . . covering design, construction, sizes and applications for the Model 300

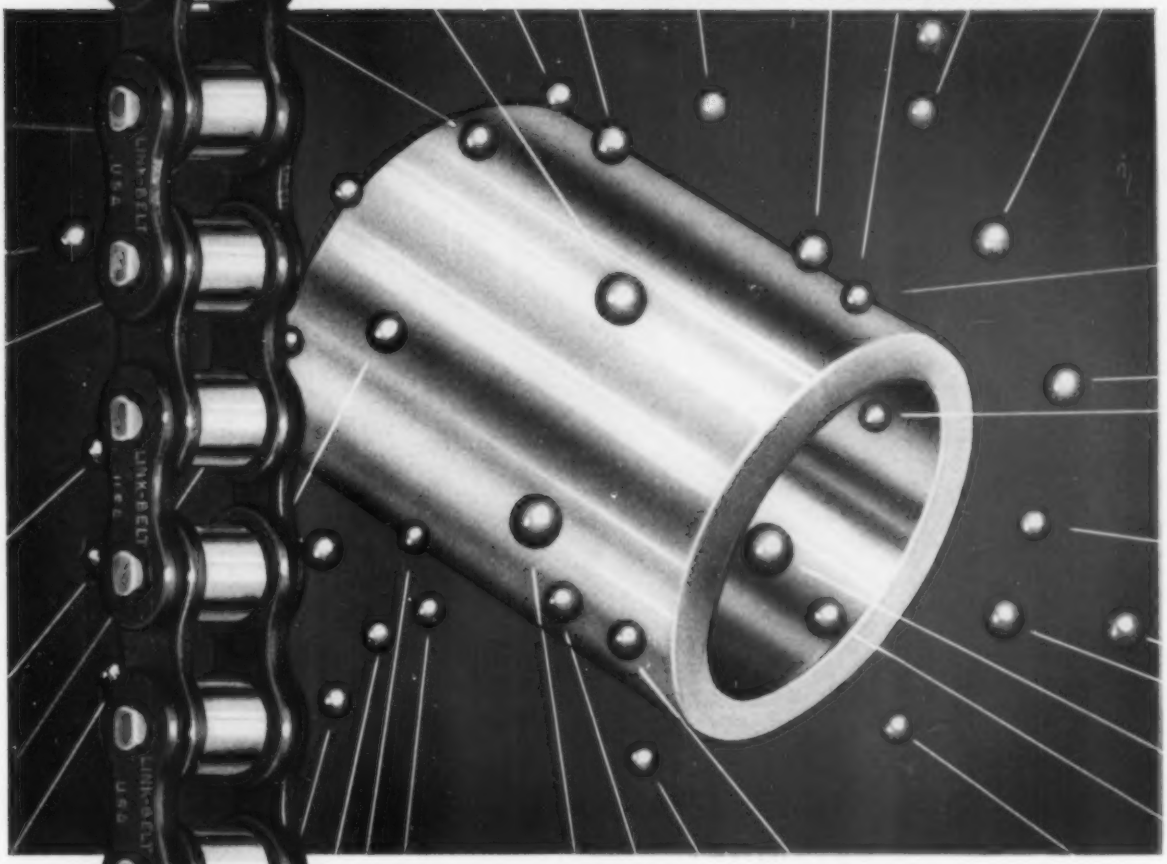
NICHOLSON

OF WILKES-BARRE

Shining example of "extra" chain quality

SILVER-BRITE

SHOT-PEENED ROLLERS



EXTRA LIFE IS POUNDED IN AND NOT POLISHED OUT

Rollers for Link-Belt precision steel roller chain are now finished by a special burnishing process to a "Silver-Brite" luster! And this is accomplished *without grinding away the benefits imparted by shot-peening*—a Link-Belt process that cold works the metal and provides extra fatigue life.

Many more special Link-Belt "extras" contribute to the dynamic strength so important for today's heavy loads and high speeds: close heat-treat control . . . lock-type bushings . . . pitch hole preparation . . . pre-stressing.

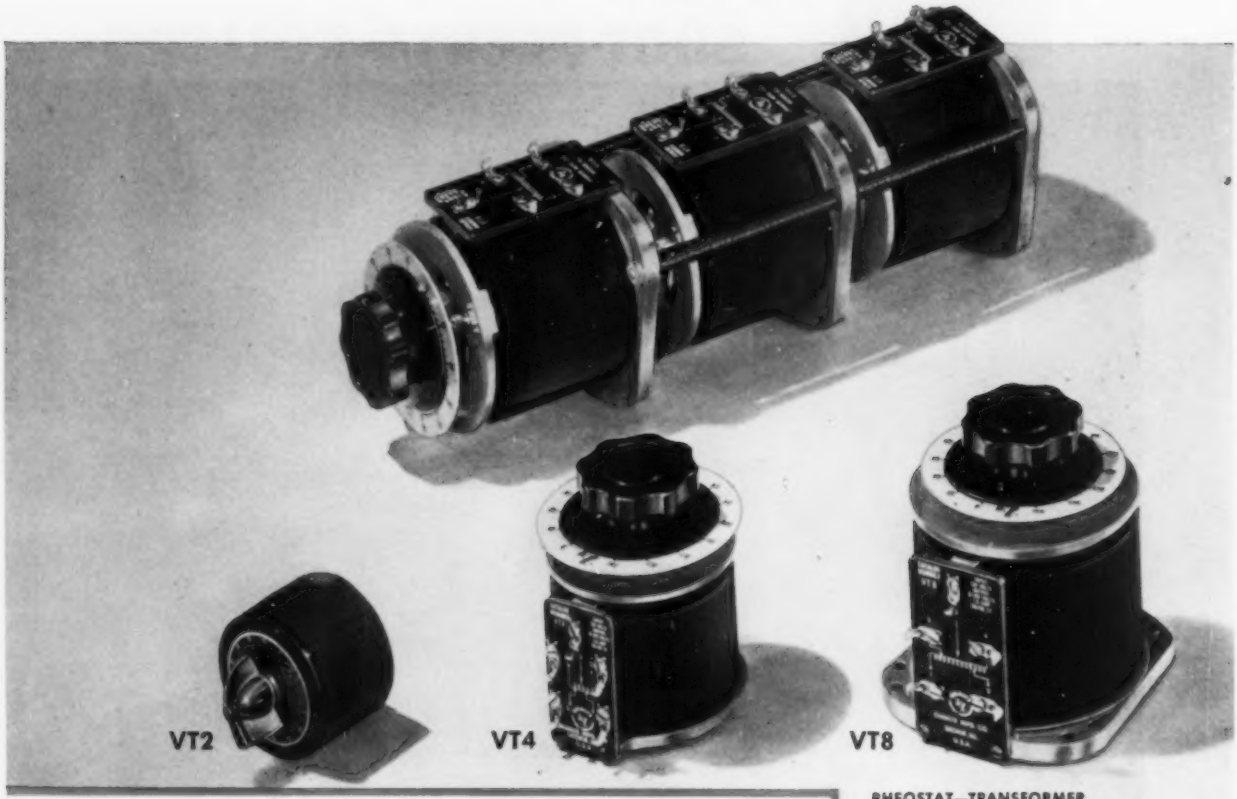
Ask your Link-Belt office or authorized stock-carrying distributor for new 154-page Catalog 2657—the most complete roller chain data book ever compiled.

LINK-BELT

ROLLER CHAINS & SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 14,976

New Sizes ! OHMITE®



EXPANDED LINE! EXCLUSIVE FEATURES!

OHMITE, universally recognized manufacturer of high quality electrical components, now offers industry an expanded line of variable transformers. The three basic models listed below provide current ratings sufficient to meet a large percentage of industrial applications. The new line is available in enclosures, tandem assemblies, and other modifications. Ohmite, the only manufacturer in the industry producing both power rheostats and variable transformers, offers rheostat-transformer tandem combinations.

UNSURPASSED OHMITE CONSTRUCTION!

Note all these advanced Ohmite "v.t." features: *greater capacity for equal size*—Models VT2 and VT4 offer a "bonus" in current at no increase in cost over comparable competitive units; *positive current transfer*, achieved in all "v.t." models—a pigtail from the brush to a large slip-ring contacts a large area of the terminal; *table or panel mounting*—on Models VT4 and VT8, shaft can be positioned for panel or table use; *interchangeable with other popular types of variable transformers*—Model VT2 has single-hole mounting, Models VT4 and VT8 match popular 3- or 4-hole mountings; *reversible direct reading dial*—calibrated on one side for normal line connection and on the other side for overvoltage connection; heavily plated rhodium brush track guarantees *longer, trouble-free performance.*

BASIC MODELS

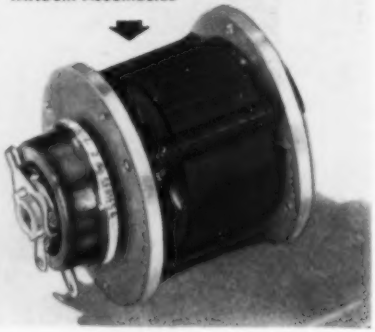
MODEL VT2
Input voltage: 120v, 60 cycle.
Output voltage: 0-132, 0-120.
Max output at any brush setting: 1.5 amp.

MODEL VT4
Input voltage: 120v, 60 cycle.
Output voltage: 0-140, 0-120.
Max output at any brush setting: 3.5 amp.

MODEL VT8
Input voltage: 120v, 50/60 cycle.
Output voltage: 0-140, 0-120.
Max output at any brush setting: 7.5 amp.

AVAILABLE FROM OHMITE DISTRIBUTORS OR DIRECT FROM FACTORY

RHEOSTAT—TRANSFORMER TANDEM ASSEMBLIES

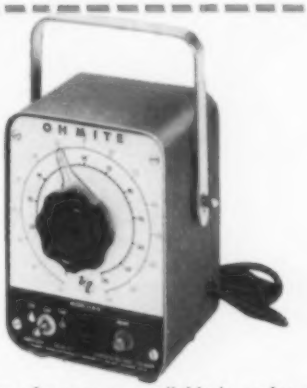


MANY VARIATIONS

Transformers can be provided with many variations to meet different requirements such as special shafts, mountings for varying panel thicknesses, auxiliary switches, taps on transformer winding for fixed intermediate voltages, and motor drives for remote control or servo-operation.

"V.t." Variable Transformers

INDUSTRY'S MOST ADVANCED DESIGN!



ENCLOSURES

Ohmite Variable Transformers are available in enclosures for portable or fixed use (back-of-panel or surface mounting). Units feature modern styling, rugged construction, and are designed for convenience.

TANDEM ASSEMBLIES

Ohmite Tandem Assemblies can be furnished in all three sizes of Ohmite Variable Transformers. Exclusive! Ohmite can also provide tandem assemblies combining famous Ohmite Power Rheostats, and Ohmite Variable Transformers.

Write for Bulletin 151

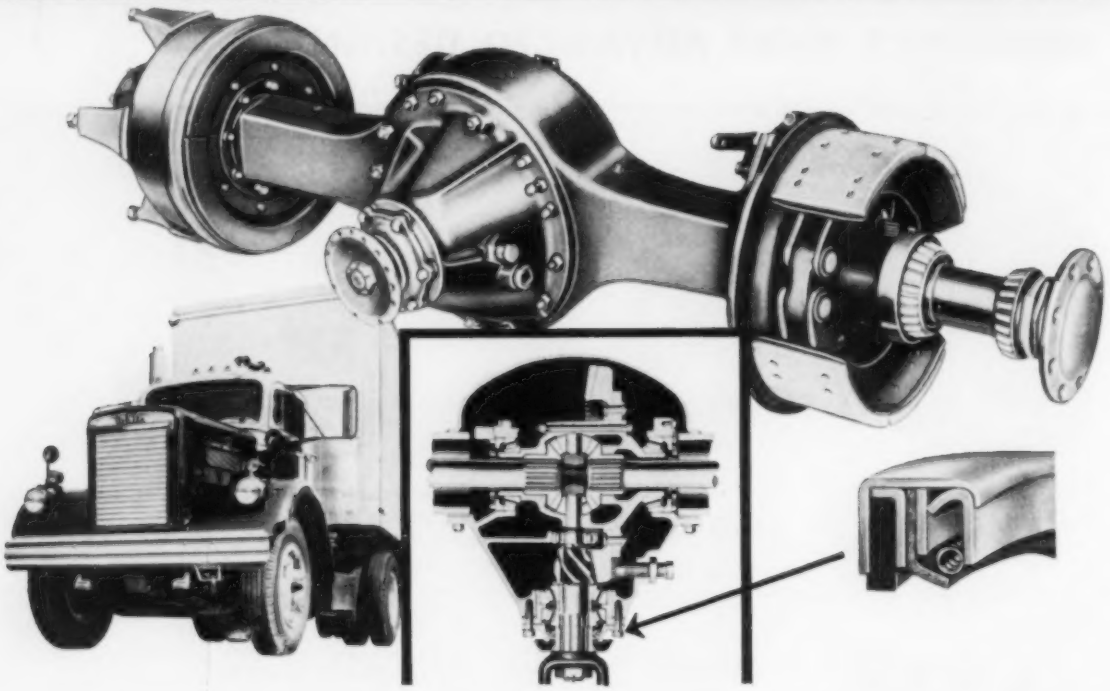
OHMITE®

RHEOSTATS RESISTORS RELAYS
TAP SWITCHES R.F. CHOKES
VARIABLE TRANSFORMERS
TANTALUM CAPACITORS

MANUFACTURING COMPANY

3611 HOWARD STREET • SKOKIE, ILLINOIS

NATIONAL OIL SEAL LOGBOOK



How White Trucks employ dual-lip National seal to protect axle pinion assembly

The use by the White Motor Company of a National 15,000 series oil seal in their 189C Single Reduction Rear Axle is a skillful employment of a standard-design seal to attain dependable and economical sealing.

Conditions at the sealing point are: S.A.E. 90 gear oil to be retained, dirt and water to be excluded, temperatures —20° to 180° F with normal operation at 150° F, maximum shaft speed 3,500 rpm, eccentricity and runout .002, shaft diameter 2¾", 15 RMS finish. Operation is of course intermittent with servicing conditions generally good.

Rather than two seals to respectively retain lubricant and exclude foreign matter, White engineers specified National 15004, a dual-lip Micro-Torc leather and felt seal wherein the leather sealing lip is spring-tensioned and faces inward to retain gear oil and the other felt lip is a wiper excluding dirt and dust.

National 15004 is but one of 2,500 different standard design seals National provides. For complete information on leather, synthetic rubber or other seals, call your National Applications Engineer. Look under Oil Seals, in the Yellow Pages.

NATIONAL SEAL

Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California;
Plants: Van Wert, Ohio, Downey and Redwood City, California

Before specifying seals, consider all these points!

Shaft RPM, Runout, Endplay
Is seal rated at or above anticipated operating extremes?

Temperature, Lubricant Types
Will heat or special-purpose lubricants attack sealing lip material?

Presence of Dirt, Foreign Matter
Point often overlooked. Should dual-lip or double seal be used?

Cost Related to Seal Design
Will a simpler, cheaper seal do as good a job as a more sophisticated design?

New Seals and Material Available
Are there new materials or compounds which can do the job better?

Special Design Oil Seals
Not all problems can be met with stock seals. Is special factory design indicated to meet special problems?

Delivery, Reputation
Is my proposed resource noted for good delivery, uniform quality and good follow-up service?

Don't specify "blind." Your National Seal Applications Engineer has up-to-the-minute oil seal information. Ask him—before you specify. Takes only a phone call; no obligation!

4994

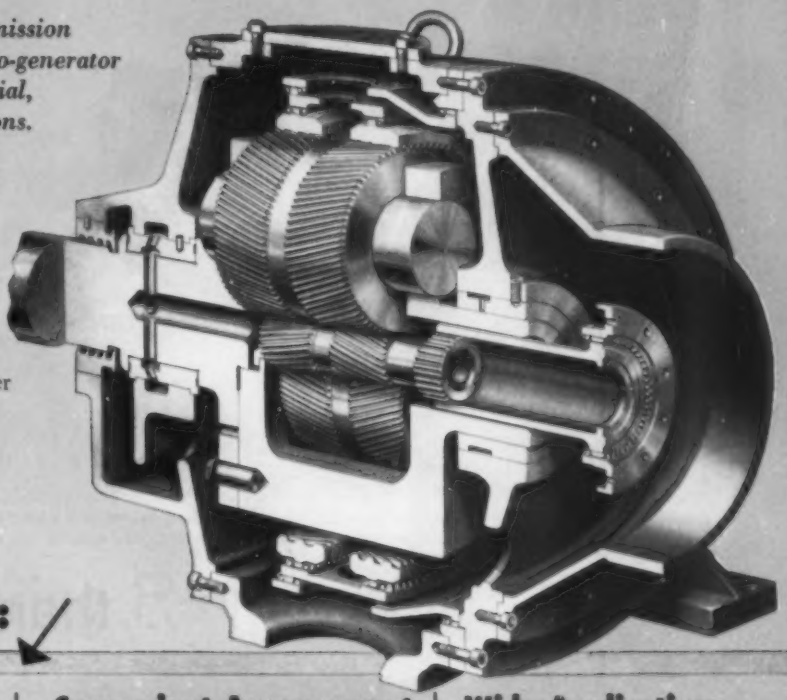
DE LAVAL-STOECKICHT
PLANETARY GEAR

...*for high speeds...high horsepower*

Proved in hundreds of installations abroad totalling over 3,000,000 horsepower—now available in America!

For all high torque power transmission applications such as pump turbo-generator and compressor drives in industrial, municipal and marine installations.

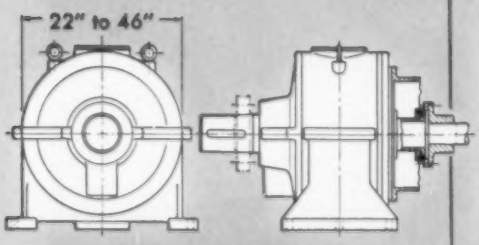
This cutaway view of the De Laval-Stoeckicht Planetary Gear shows how it provides flexibility for proper load distribution throughout the gear members. The thoroughly proved and tested design is completely reliable in transmitting high horsepower for high speed applications. • Highest efficiencies (98% or higher)...no high speed bearings...less friction losses.



Check These Advantages:

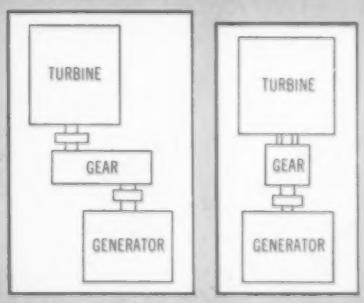
Small Size—Light Weight

Compact—low weight per hp. Sizes range from 22" to 46" in diameter, depending on horsepower requirements. Example: 5000 hp planetary unit weighs 1700 lbs. against 6000 lbs. for conventional gear.



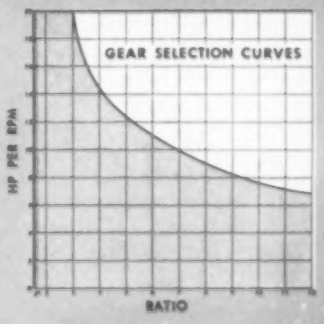
Convenient Arrangement

Co-axial or "in-line" arrangement of gear members takes up far less space than parallel axis gears of equivalent horsepower rating.



Wide Application

Capacity range shown in shaded area on chart below. For other applications, contact your De Laval Sales Engineer.



For further details, write for Bulletin 2400.

DE LAVAL *Steam Turbine Company*

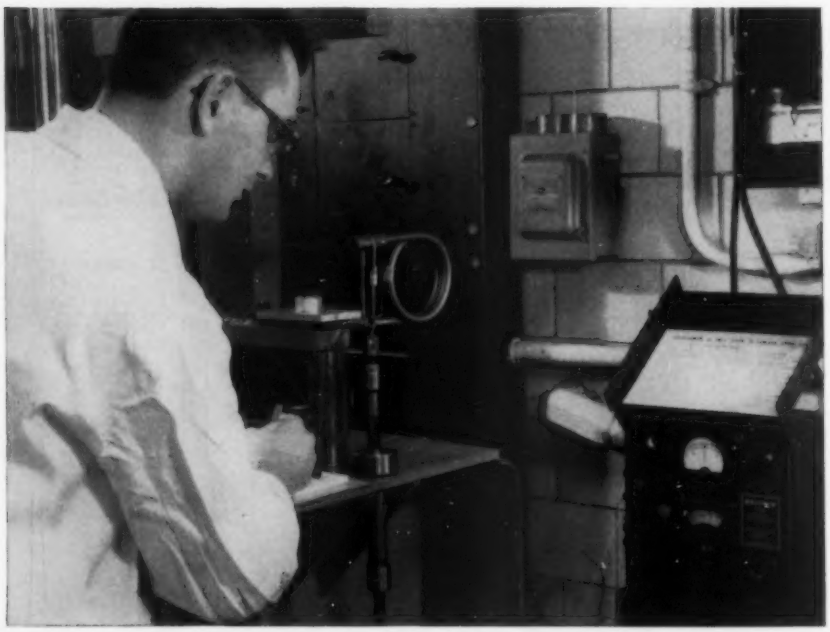
801 Nottingham Way, Trenton 2, New Jersey

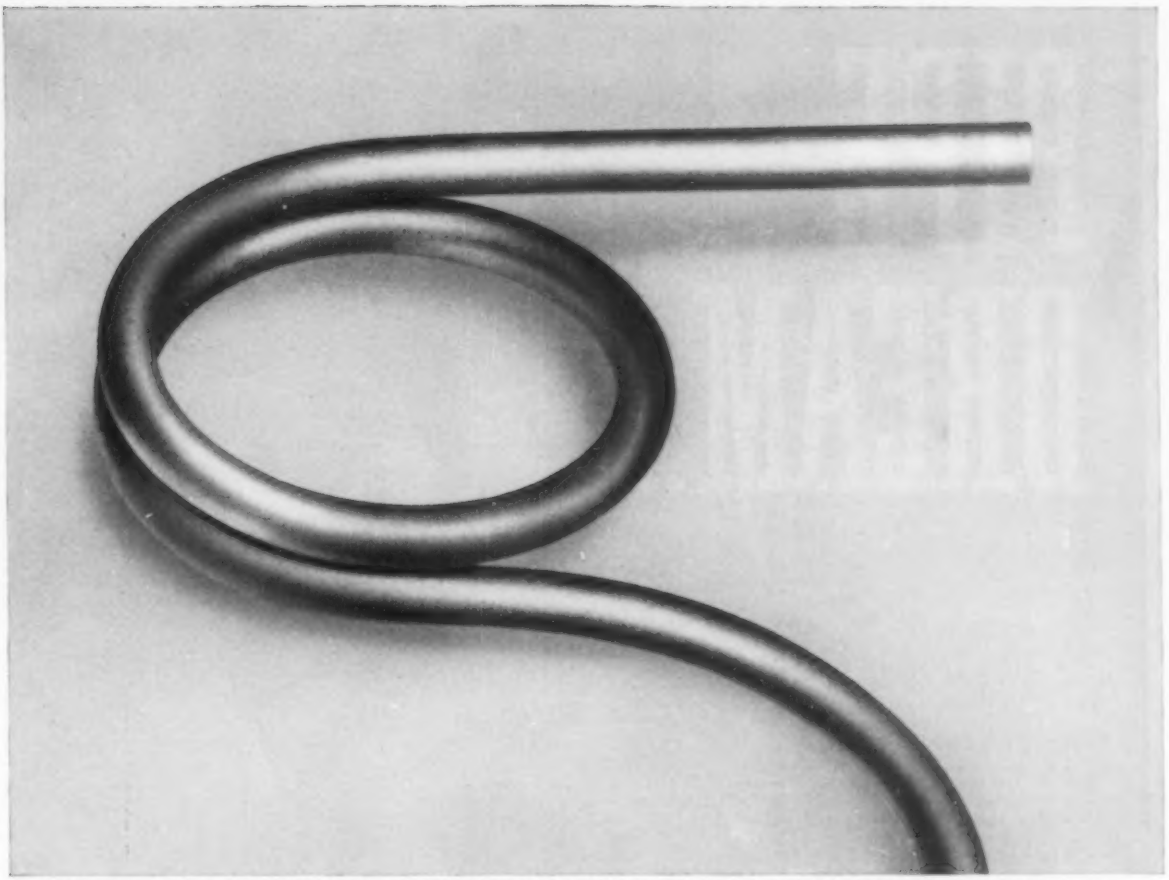
DL491

20,000 chairs rock on (USS) American Springs without one failure

...thanks to AS&W

In the American Steel & Wire Spring Testing Laboratory, the springs recommended for the Homecrest Chair go through extensive tests. This Fatigue machine, by means of strain-gauge verification, simulates years of use in a relatively short testing time.





Here is the spring recommended by American Steel & Wire for use in this chair. To supplement the AS&W tests, the Homecrest Company subjected these springs to a simulated rocking test. Under a weight of 250 pounds, these springs were rocked 750,000 times, without failure.

Spring Engineering Research Service

The Homecrest Company, Wadena, Minnesota, wanted to add a swivel rocking chair to their line of modern, functional home furniture. However, they would produce this chair only if it could be a quality item that would give good, dependable service. While designing the chair, they checked with the American Steel & Wire Spring Engineering Consulting Service. The engineers studied the problem, ran extensive tests and finally recommended a pair of round wire helical single coil torsion springs. Using these springs, Homecrest designed, fabricated and marketed the chair. Today 20,000 of these chairs have been sold and not one failure of an AS&W Spring has been reported.

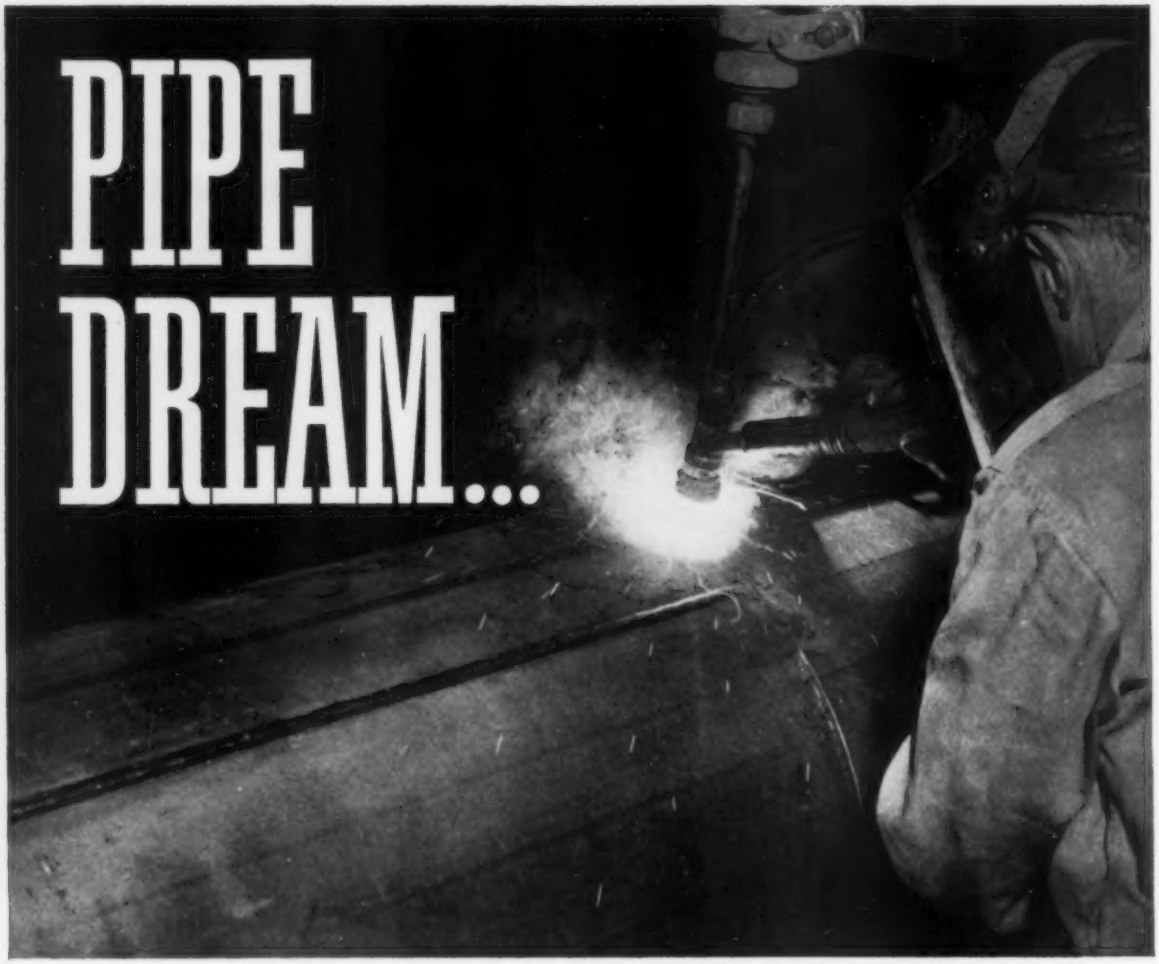
Mr. A. L. Englemann, a partner of Homecrest Company, says, "We have purchased from American Steel & Wire over 45,000 springs, and not one has been reported a failure. We couldn't be happier with American Steel & Wire as a supply source for our springs."

If you have a spring problem, or would like advice on the use of springs in your product, get in touch with any American Steel & Wire Sales Office. You can benefit from the knowledge of AS&W's Spring Engineering Research Service. The Service has been engaged in laboratory experiments of static and dynamic testing for 20 years and has accumulated invaluable data on stress and fatigue life of steel springs, while endeavoring to improve efficiency in the use of steels, from steel chemistry through product application, to more economically cope with today's rigorous demands. This accumulated knowledge of the AS&W Spring Engineering Research Service is at your disposal.

USS and American are registered trademarks

American Steel & Wire
Division of USS **United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors • United States Steel Export Company, Distributors Abroad



...UNIONARC Welding saves $7000 on one production run

UNIONARC Welding—LINDE's new electric welding method for steel—increased production by 300% and saved a western pipe mill $7000 on a single run of steel pipe. Replacing covered electrode methods, UNIONARC Welding is expected to save this company $150,000 a year.

UNIONARC Welding uses a continuously-fed wire electrode, magnetically coated with flux and shielded with carbon dioxide gas. It has three times the speed and weld penetration of covered electrode welding. And UNIONARC Welding gives you "finished", X-ray quality welds and low hydrogen deposits—in all welding positions.

See for yourself—ask your nearest LINDE representative to *prove* that UNIONARC Welding slashes time and labor costs over conventional methods. Call your local LINDE office today! Or write Dept. P-102, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. In Canada: Linde Company, Division of Union Carbide Canada Limited.

Linde TRADE-MARK

UNION CARBIDE

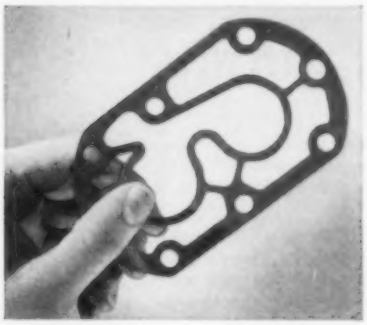
"Linde", "Unionarc", and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

Technical data for gasket design and selection

NUMBER FIVE

Choosing a gasket for compressors

In selecting a gasket material for a compressor head, the first consideration is the gasket's ability to withstand the usual ambient temperature of about 300° F.



At such elevated temperatures, and with internal pressures ranging well over 100 psi, torque retention becomes another critical factor.

In the case of refrigerator compressors, the choice of a gasket is further limited by the presence of refrigerant gases which attack many gasket materials.

A material that meets these requirements is Accopac AN-890, a new beater-saturated gasket material pioneered by Armstrong. Accopac AN-890 is a blend of refined asbestos fibers with a nitrile-type rubber binder.

AN-890 withstands temperatures up to 800° F. Its nitrile-type rubber binder swells slightly in the presence of refrigerant gases. Since these gases do not deteriorate AN-890, the swelling acts to maintain a tight seal.

Bolt torque retention of Accopac AN-890 has been proved by comparing a flange containing refrigerant gas at 350° F. and 150 psi, and a control flange at room temperature and no gas. Accopac maintained bolt torque equally well in both flanges.

Because of the thorough refining of the asbestos fibers, AN-890 die-cuts cleanly. It also costs less than conventional asbestos materials.

For more information, write for a copy of our new folder, IND-915.

How heat affects the selection of resilient gasket materials

In selecting a resilient gasket material for use where the temperature at the gasket line will be substantially higher than room temperature, the various effects of heat must be considered.

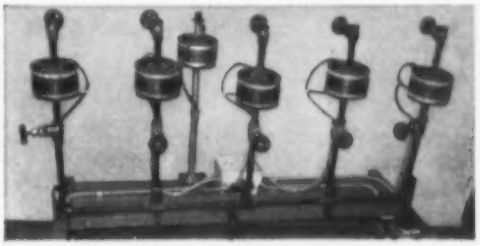
In many cases, heat is less of a limiting factor than is commonly supposed. If a designer knows the range of temperature limits of the various classes of resilient gasket materials (see table), he may find that a resilient material offers service equal to a more expensive gasket.

A more subtle effect of heat—and one more difficult to detect—is the softening it tends to produce in almost any non-metallic gasket.

Generally, this is manifested by things variously known as torque loss, stress relaxation, and creep. Because of plastic flow or some form of fatigue, high temperatures tend to reduce the ability of a resilient gasket to maintain flange pressures over relatively long periods.

Loss of bolt torque induced by heat can be minimized by selecting a gasket material with good torque retention properties. The Armstrong Accopac line includes several such materials. Generally, the denser the gasket the better its torque-retention properties, (see table). In addition, where heat is involved, it is all the more important that initial bolt loads be adequate.

A more complete discussion of the effects of heat on resilient materials is contained in the new Armstrong Gasket Design Manual. Write for your copy today.



This apparatus—called the "hot spider"—permits simultaneous testing of gasket materials at temperatures up to 750° F. and internal pressures up to 500 psi under varying conditions of flange loading.

Class of material	Maximum sustained temperature at gasket line*	Rank in order of torque retention
Asbestos	750° F.	1
Cellulose	300° F.	2
Cork-and-rubber	250° F.	3
Straight rubber	250° F.	4
Cork composition	250° F.	5

*These are recommended design limits. Obviously, in many applications temporary exposure to higher temperatures can be tolerated. Consideration should also be given to nature of contained fluids, since some fluids which are inert at room temperature become more active as temperatures increase.

Resilient gaskets usually are organic, and exposure to high temperatures can cause physical damage such as charring. If charring does occur, the damage will, of course, be obvious and leaks will result. This can generally be avoided by staying within recommended limits of the material or by using an inorganic gasket such as Armstrong asbestos Accopac.

Send for a copy of the new Gasket Design Manual, IND-763, containing 34 pages of valuable information for engineers. Armstrong Cork Co., 7010 Irvin Street, Lancaster, Penna.

Armstrong GASKET MATERIALS

... used wherever performance counts

NOW.. from MUELLER

cold·prest® IMPACT

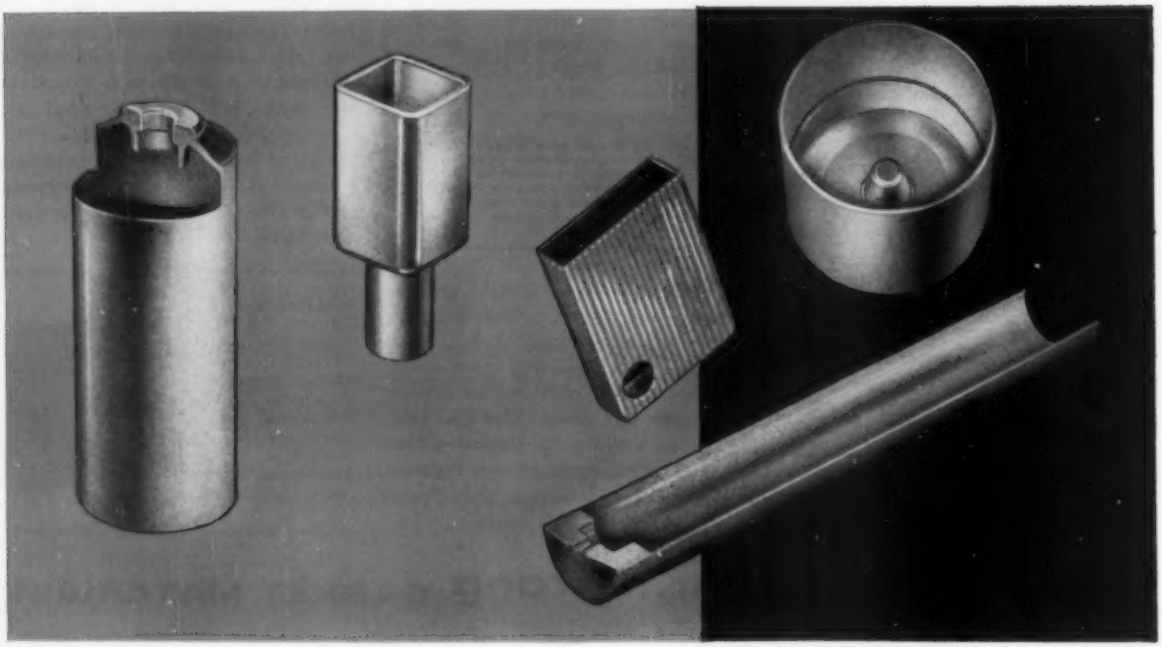
the amazing, new, chipless metalworking method that cuts production costs... ....improves part quality

Cold-Prest Impact Extrusions are here. This amazing new method of producing parts to closer tolerances . . . with better physical characteristics, and with absolutely no waste and at extemely high speed is the greatest development in metal-working in the last 20 years. And it's proving to be the most practical method of manufacturing a staggering number of designs that combine cold forged bases with shells shaped as rounds, ovals or rectangles.

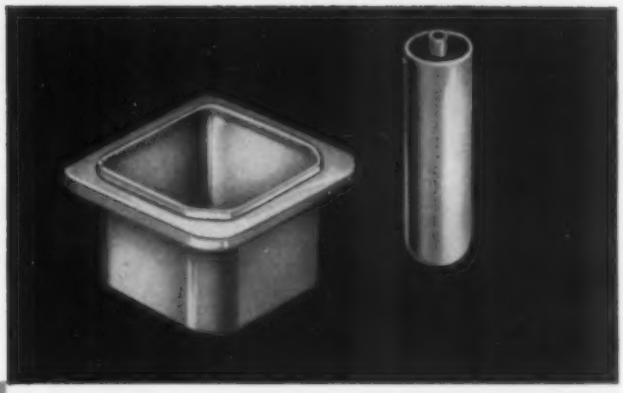
Here are some of the reasons why your company can save money and improve product quality . . . by specifying Mueller Brass Co. Cold-Prest Impact Extrusions. Parts are formed with *no chip loss;* you pay only for the metal that goes into the part. Because of the dimensional accuracy of Cold-Prest extrusions, parts can be held to closer tolerances and many costly secondary machining operations are eliminated. They have better physical properties with actually less metal needed to achieve greater strength.

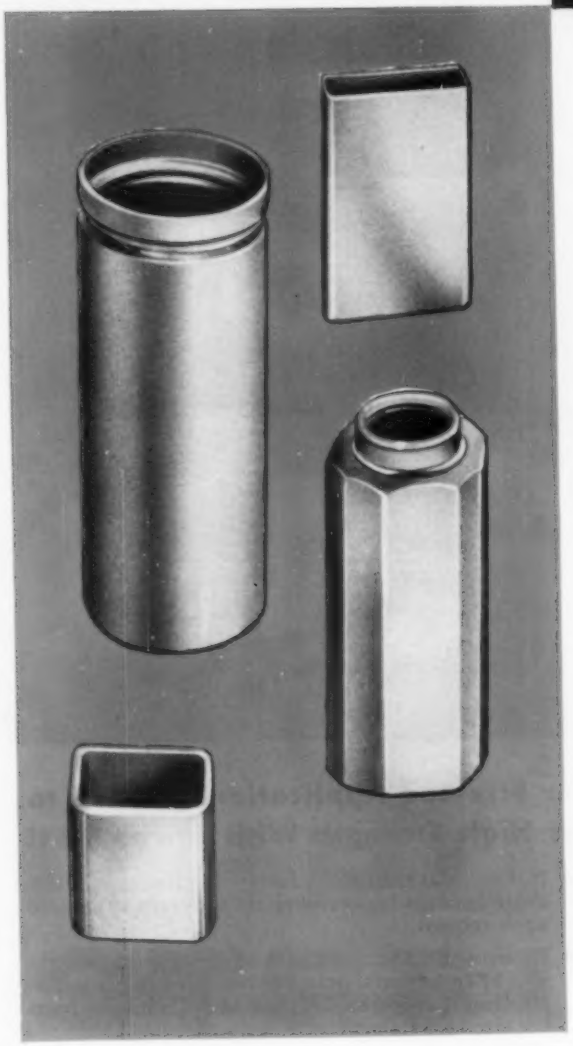
Cold-Prest Impact extruded parts often *reduce or eliminate assembly operations* because products employing several parts can often be made as a single extrusion. Also, complex parts produced by conventional methods requiring costly machining to close tolerances can be made in *A SINGLE OPERATION* as a Cold-Prest extrusion, saving raw material, costs of time, tools and labor . . . as well as assuring a positive leak-proof part.

These are the outstanding reasons why you should consider Cold-Prest Extrusions when you are specifying and purchasing fabricated metal parts. Call a Sales Engineer from the Mueller Brass Co. . . . he will be glad to discuss your problems and answer your questions. Write today for our new 16 page engineering manual on "Cold-Prest Impact Extrusions".



BRASS CO.
EXTRUSIONS





MUELLER BRASS CO. SERVICES mean better designed, better engineered, lower cost cold-prest extruded parts

To produce precision, high quality impact extrusions, Mueller Brass Co. combines all the important factors of design, engineering and production in its Cold-Prest extrusion process. Trained engineers take into consideration such elements as functional strength, finished appearance and proper control of metal flow. Mueller Brass Co. offers this design engineering service to its customers, and engineers are always available for consultation.

Here a die and punch assembly, made to exacting tolerances and with a mirror-like finish, receives a final inspection in the tool and die shop before being sent to the production department. Skilled craftsmen work with the best equipment available to produce these precision tools and dies. Technical skill, modern equipment and complete engineering services are available at no extra cost to you.

MUELLER BRASS CO.

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

259

PORT HURON 22, MICHIGAN

Republic Steel Announces Result of Project 501...

A NEW HIGH STRENGTH POWDER

Type 6460 Developed for Use in Higher Stressed Applications! Suited to Existing Operating Equipment! Provides High Strength With Lower Cost!

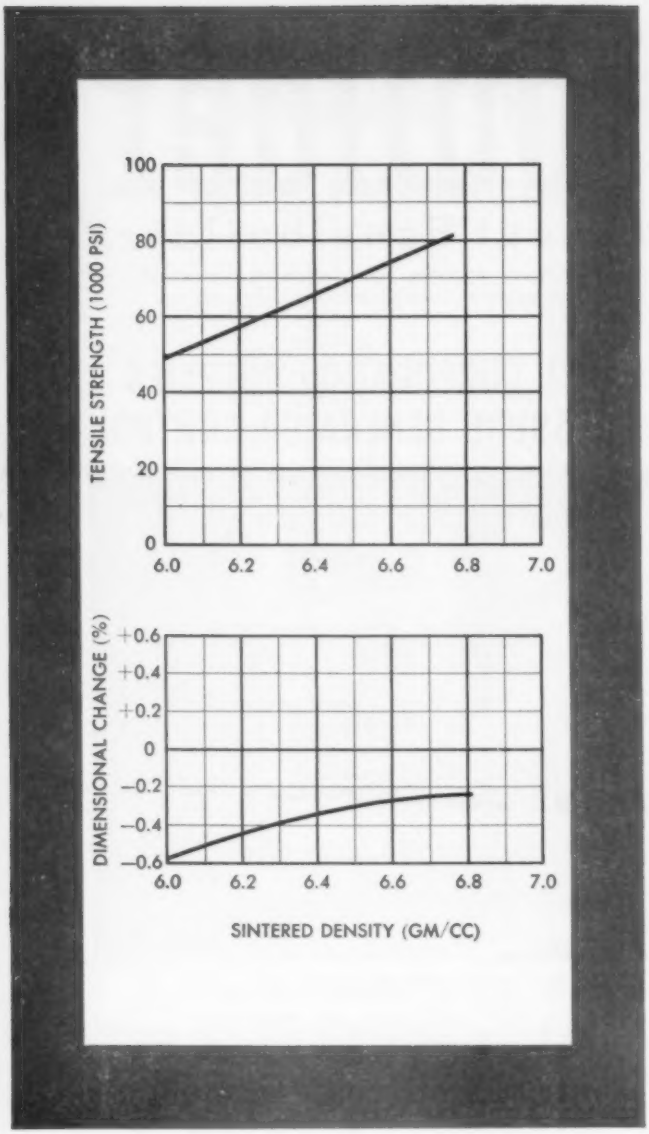
Again, the big news in the powder metallurgy industry comes from Republic Steel. First, Republic gave the industry powders with controlled dimensions. Now, at its Toledo, Ohio plant, Republic has developed, tested, and is *producing* a new **H**igh **S**trength Powder which permits the use of sinterings for highly stressed parts.

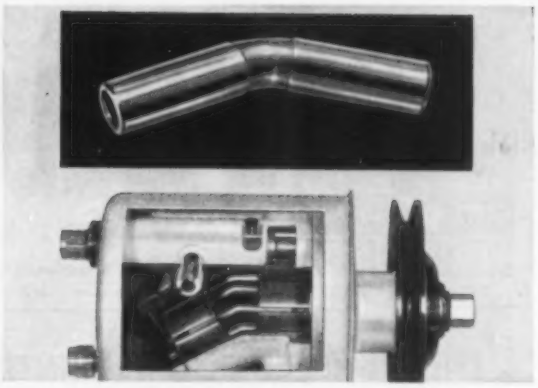
This new powder, designated Republic Type 6460, provides these advantages and features:

- Minimum tensile strengths at 6.4 density of 60,000 p.s.i. as sintered, and 100,000 p.s.i. heat treated, as determined on standard MPA Test Bar.
- *Can be used with existing operating equipment.*
- Normal briquetting pressures—30 to 35 tons to obtain a density of 6.4 grams/cc.
- Normal sintering cycles—2030°F. to 2050°F.—45 minutes—Endo Atmosphere.
- Normal heat treat procedures—additional information to obtain higher physical properties available upon request.
- Dimensional characteristics after sintering acceptable by commercial practices indicated by the industry—less than .004 inches per inch shrinkage from die size at 6.4 density.
- Available in *production quantities* up to and including 12 tons, or in multiples thereof.

Republic Type 6460 Powder represents an entirely new, but thoroughly practical material for the powder metallurgy industry. It opens the way to new markets for new applications of **H**igher **S**tressed parts at lower costs.

Our metallurgists and engineers are ready to help you utilize all the advantages of Republic Type 6460 Powder. Just mail the coupon to obtain their services, or for technical data sheet on Type 6460 Powder.





WHEN IT'S MOVING . . . MAKE IT TUBING. Republic ELECTRUNITE Mechanical Tubing meets all close tolerance requirements for new Thompson Products automotive hydraulic pump assembly. Close tolerance, uniformity, ductility, workability—four important performance requirements, all important reasons why ELECTRUNITE is used. Will-O-Hill Industries, Inc. Willoughby, Ohio, sub-contractor, cut 7/16-inch diameter ELECTRUNITE into units 2 3/16 inches long. Each unit is rolled to form a slight groove in the center and bent to an angle of exactly 150°. Nine such pieces are used in each pump assembly. Send coupon for more information.

STRENGTH, LIGHTWEIGHT, CORROSION-RESISTANCE are advantages of Republic Titanium used in the manufacture of these hemispheres by Alloy Products Corporation, Waukesha, Wisconsin. Used for special aeronautical applications, completed spheres provide light weight without impairing safety; strength to contain 2,000 psi.; extremely high corrosion-resistance to chemically active contents. Beyond providing product advantages, Republic Titanium is easy to draw, pierce, and weld. Little change in fabricating procedure is required as compared with other construction materials. Send coupon for data.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

REPUBLIC STEEL CORPORATION
DEPT. PE-5430-A
1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

☐ Have a powder metallurgist call.
Send more information on: ☐ Type 6460 Powder
☐ ELECTRUNITE® Tubing ☐ Titanium

Name_____ Title_____
Company_____
Address_____
City_____ Zone____ State_____

The Panelbuilder

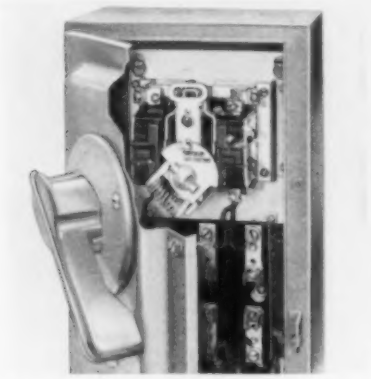
66 YEARS OF SERVICE
CUTLER-HAMMER CONTROL C-H

News for and about Panelbuilders

Cutler-Hammer Inc., Milwaukee, Wis. *Division:* Airborne Instruments Laboratory. *Foreign:* Cutler-Hammer International, C. A.
Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation, Inc.

CUTLER-HAMMER MOTOR DISCONNECT SWITCH SIMPLIFIES PANEL ASSEMBLY

Panelbuilders using the Cutler-Hammer 10904 Motor Disconnect Switch report it provides important savings in time and effort in the assembly of their control panels. The complete unit consists



3/16" radial adjustment of the cover mounted mechanism assures correct alignment with panel mounted disconnect switch.

of a contactor type disconnect switch mechanism, adjustable operating shaft, cover interlock, and external operating mechanism. The switch mechanism uses the same basic structure of the famous Cutler-Hammer Three-Star Contactor, and is easily panel mounted and wired. To mount the external operating handle mechanism, five holes are drilled in the cover following template directions provided with each unit. Exact alignment of these mounting holes with respect to the switch mechanism isn't critical. Compensation for misalignment is provided through the operating handle mechanism's 7/16" radial adjustment. The Cutler-Hammer 10904 Motor Disconnect Switch can be used in any enclosure where the panel-to-cover depth is between 5¾" and 20¾". External operating mechanisms are also available for type F, G, J, K, KL, and L circuit breakers. For further information write for Bulletin 10904-V-249, Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

CONTROL PANEL CORPORATION SUPPLIES HYDRAULIC PRESSURE GENERATOR CONTROL

One of thirty hydraulic pressure control units supplied by the Control Panel Corporation equipped with Cutler-Hammer Components.

During the past five months the Control Panel Corporation of Chicago, Illinois, has supplied a large number of these compact, NEMA 12 enclosed hydraulic pressure generator control units. The control units are used in conjunction with high speed riveting on a mass production assembly line. Typical of the control equipment used on high volume production machinery, every effort was made in the choice of the components to insure dependable, trouble-free operation.

Mr. H. A. Hart, President of the Control Panel Corporation, reports: "It has been our experience the proper performance of any machine powered by electric motors depends directly upon the control equipment used . . . no machine can be more dependable than the

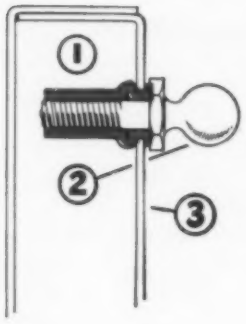
Mr. H. A. Hart

control which directs and protects it. This is why we and many of our customers consider a component's record of performance an important factor when selecting the components to be used in the controls we supply."

PANEL BUILDERS HANDBOOK SIMPLIFIES SELECTION OF ELECTRICAL COMPONENTS

This handy 70 page reference guide is specifically edited to assist design engineers and control panelbuilders in the selection of electrical control components and control accessories. Every effort was made to make this book as concise as possible, and yet it includes such vital information as wiring diagrams, dimension drawings, ratings, ordering information, and a maintained price list. Address your request for your personal copy of Bul. EE120-V-249 on your company letterhead. Cutler-Hammer Inc., Milwaukee 1, Wisconsin.

B.F.Goodrich B. F. Goodrich Rivnuts® solve 3 fastening problems at once!

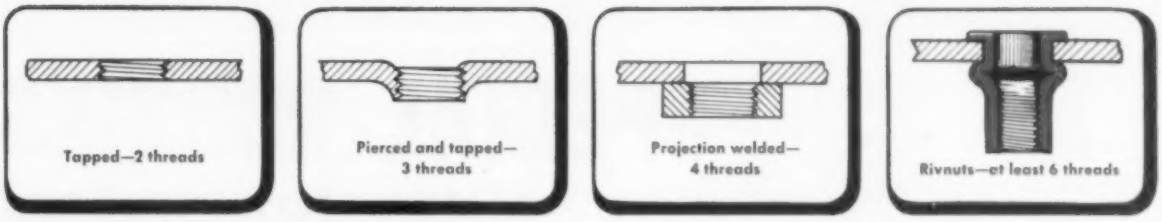


A RIVET WAS NEEDED for doors of metal cabinets that 1) could be installed from one side only, 2) would serve as a nut plate for a knob attachment and 3) could be installed after enameling. B. F. Goodrich Rivnuts proved the perfect answer.

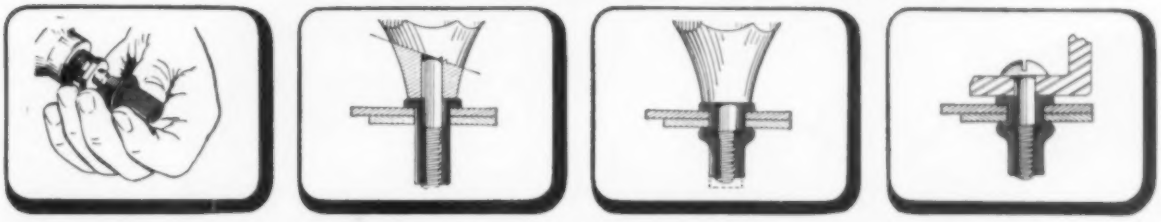
A flat-head Rivnut is inserted in the sheet metal door. Working from one side, one man can upset Rivnuts in seconds with easy-to-operate heading tool. Bulge formed in Rivnut shank grips the metal tightly. The knob of the catch is then threaded into the clean, still-intact Rivnut threads. Rivnuts are installed after enameling—without marring the finish.

B. F. Goodrich Rivnuts, the only one-piece blind rivets with threads, save many man-hours on the job. If you have a fastening problem, why not put it up to B. F. Goodrich engineers?

Compare these 4 methods of putting screw threads in thin sheet metal:



Rivnuts provide at least 6 clean threads in one simple operation!



1 Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.

2 Rivnut is inserted—head firmly against work—tool at right angles to work.

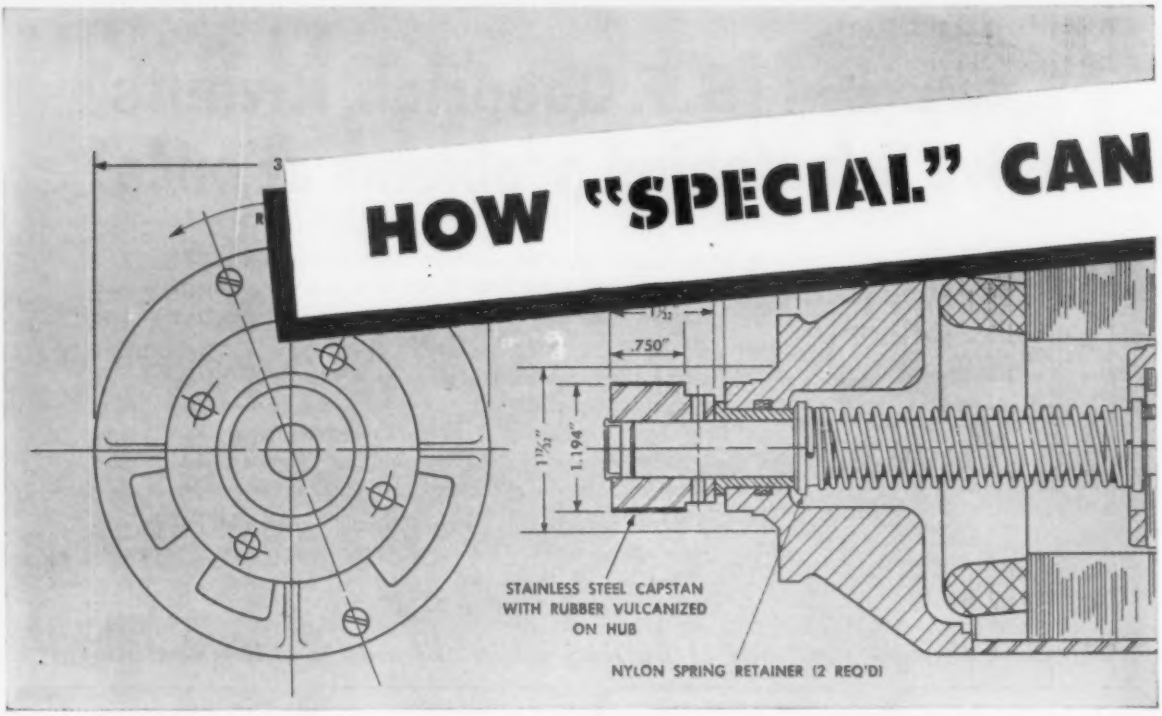
3 Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.

4 After upset, Rivnut threads are still clean and intact, ready for screw attachment.

SEND NOW FOR FREE RIVNUTS DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten TO and fasten WITH. Explains construction, gives proved applications. Write for your free copy today to *B.F.Goodrich Aviation Products, a division of The B. F. Goodrich Company, Dept. PE-108, Akron, Ohio.*

B.F.Goodrich *aviation products*



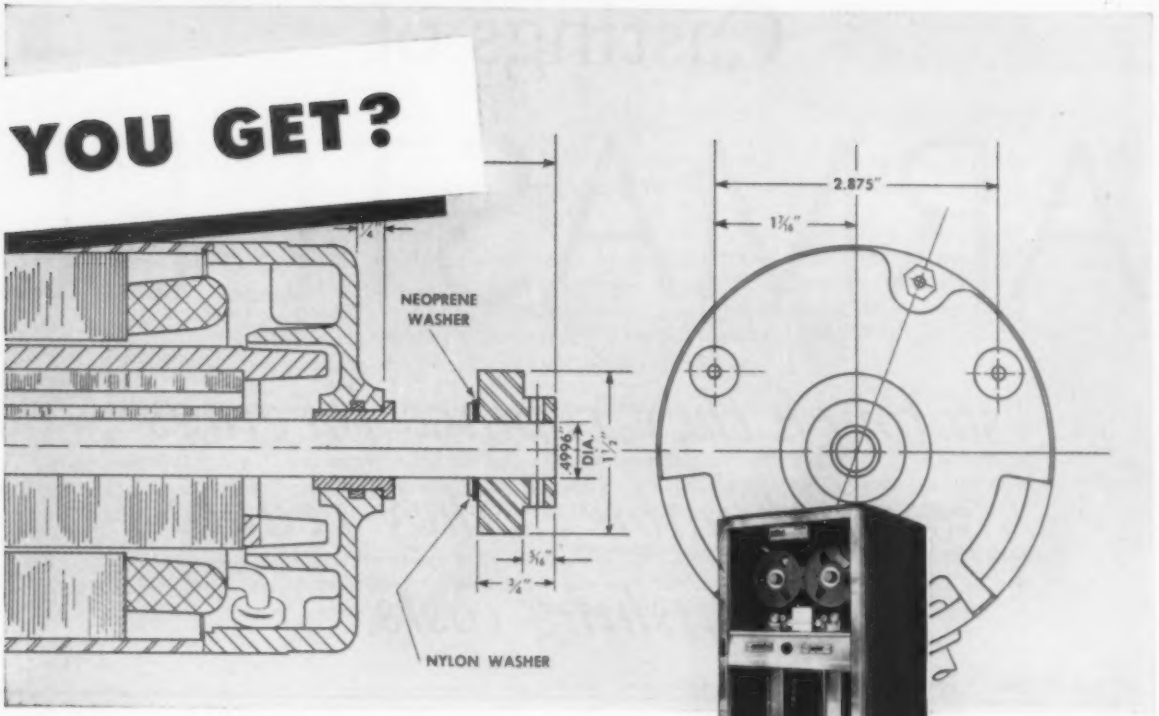
SPECIAL ROBBINS capstan motors function

SPECIFICATIONS

Reluctance synchronous motor, 1/20 HP, 60 cycle, 3 phase, 208 volts ± 8%, 1200 RPM . . . Rotor dynamically balanced to commercial specifications . . . Shaft is shown in position when motor is stopped . . . When motor is running at synchronous speed, a minimum axial force of 350 grams is required with spring in place before displacement occurs . . . When rotor is in its retracted position and power is applied, the minimum axial force developed with spring in place is 100 grams . . . When power is cut off, the spring retracts the rotor with minimum 50 gram force while rotor is rotating.

Robbins & Myers builds motors from 1/200 to 200 horsepower

YOU GET?



& MYERS
accomplish unique in IBM'S 727 magnetic tape unit!

SHAFT ROTATES AND MOVES AXIALLY

Two of these special R&M motors are used in each of IBM's 727 Magnetic Tape Units. They answer IBM's need for a tape unit drive motor with a retractable capstan. The rotating shaft moves axially when the motor is started or stopped.

A spring holds the rotor, shaft and capstan in retracted position when the motor is stopped. When started, as the motor attains synchronous speed, axial force created as the rotor centers itself in the field becomes sufficient to overcome spring resistance. The capstan moves into engaged position and sends the tape reels rolling. Another capstan on the opposite end of the shaft (at right in drawing) actuates two microswitches as the rotor returns to retracted position when motor is stopped.

Four additional R&M fractional horsepower motors perform other high-speed power tasks within the tape units—driving reels, rewinding, unloading tape and retracting guide mechanisms.

R&M motors meet strict IBM engineering requirements: precise adaptability to special functions, capacity for lightning starts and stops, and absolute dependability. R&M can also design and build motors of highest quality designed to your exact specifications. For reliable fractional power, contact Robbins & Myers!

R&M

ROBBINS & MYERS, INC.
SPRINGFIELD, OHIO / BRANTFORD, ONTARIO

MOTORS FANS HOISTS MOYNO PUMPS INDUSTRIAL PROPELLAIR FANS

Castings of

ARMASTEEL®

so tough they replace forgings so machinable...they reduce finishing costs

CLASSIFICATION	CHARACTERISTICS	HARDNESS (BHN)	MIN. TENSILE STRENGTH (PSI)	MIN. YIELD STRENGTH (PSI)	MIN. % ELONGATION IN 2 INCHES
ARMASTEEL GM 86M	Recommended for less highly stressed parts. Replaces steel parts in 1020-1035 S.A.E. range.	163-207	70,000	48,000	4.0
ARMASTEEL GM 85M	Recommended for moderate strength plus adaptability to selective hardening. Replaces parts in 1035-1050 S.A.E. range.	197-241	80,000	60,000	3.0
ARMASTEEL GM 84M	Recommended for high degree of strength. Replaces heat-treated parts in 1040-1050 S.A.E. range.	241-269	100,000	80,000	2.0
ARMASTEEL GM 88M	High resistance to wear and high yield strength, yet retains machinability. Requires no heat-treating and possesses same strength and wear characteristics as alloy steel forgings.	269-302	105,000	85,000	2.0

CENTRAL FOUNDRY DIVISION

Because ARMASTEEL castings are so machinable, so resistant to wear and shock, and so adaptable to selective hardening, they are rapidly replacing many parts formerly machined from bar stock or steel forgings.

ARMASTEEL, a pearlitic malleable iron, possesses the same strength and performance characteristics usually associated with plain carbon steel. In addition, ARMASTEEL contains excellent bearing properties, has high yield strength, good damping capacity, maximum rigidity and excellent fatigue life. Accurate control of heat-treating operations in the manufacture of ARMASTEEL produces a fine, uniform grain structure and provides excellent finishing qualities.

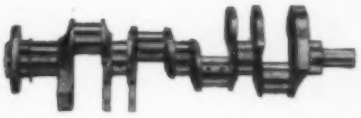
Four different types of ARMASTEEL can be cast to your specifications. One of the four (GM 84M, GM 85M, GM 86M or GM 88M) will have the physical properties to best meet the requirements of your application. For example, ARMASTEEL castings are being successfully used in the automotive, appliance and implement fields for such parts as gears, pistons, crankshafts, rocker arms and universal joint yokes, all of which utilize to best advantage the outstanding characteristics of ARMASTEEL.

Some of these applications are shown in the table. Look them over carefully; you may find that these characteristics and advantages of ARMASTEEL can help reduce your costs . . . increase your production . . . and improve the performance of your products.

Typical ARMASTEEL castings

Because of the greater physical properties of GM 86M ARMASTEEL, it was possible to redesign this anchor plate as shown and effect a weight reduction from 2.26# per piece to 1.44# per piece.

GM 86M ARMASTEEL provides the ideal casting for this automobile differential case because of its high strength, minimum deflection and good damping qualities which contribute to quietness of operation. Note the as-cast internal cavity and the well-formed webs.



GM 85M ARMASTEEL provides a crankshaft with more desirable machining characteristics than a forged crankshaft of SAE 1045 steel. Improves machining of journals and reduces chocking stock. Use of GM 85M ARMASTEEL made possible the redesign of the crankshaft with a resulting 3.5# weight reduction and a lower material cost.

By converting to GM 85M ARMASTEEL, drilling and boring operations were eliminated on this crankshaft sprocket. Stock in rough part was reduced from 1.93# in forging to 1.00# in casting. Customer realized reduced piece price with GM 85M ARMASTEEL.

GM 84M ARMASTEEL was specified for this socket plate journal because its microstructure makes it more easily machined than steel with the same physical properties. It has better bearing and wear resistance qualities . . . less distortion during machining . . . and does not require heat treatment. Weight of part in rough is less than comparable steel forging.

Crankshaft for newly designed small gasoline engine. GM 84M ARMASTEEL specified because of outstanding success in similar engines. Less stock removal and better machinability are advantages over forged crankshaft.

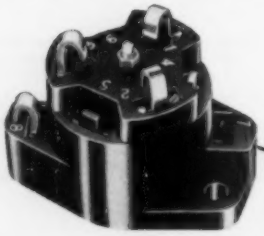
This planet gear carrier was formerly forged from SAE 1141 steel, which required a heat treatment after rough machining and broaching operations. By converting to GM 88M ARMASTEEL, heat treatment was eliminated and the weight of the rough part was reduced.

By converting to GM 88M ARMASTEEL for this universal joint yoke, hole thru hub could be cast in . . . eliminating a drilling operation and reducing weight of part approximately 30%. GM 88M ARMASTEEL part has lower piece price than forging formerly used.

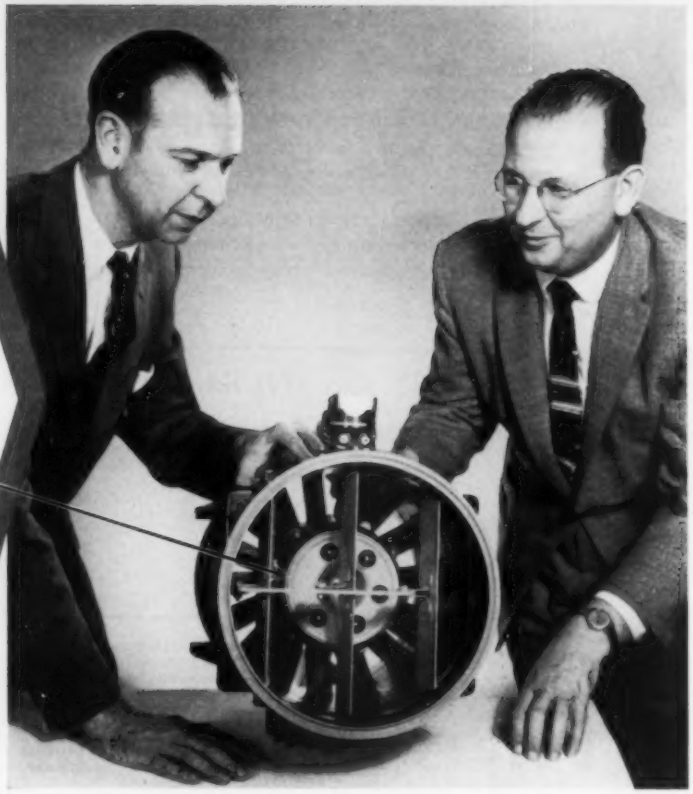
85

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN • DEPT. 10

KLIXON
3-PHASE AIRCRAFT MOTOR PROTECTORS



Guard Against Overtemperature in AiResearch Condenser Fan



Roy Schinnerer, left, Senior Project Engineer, and Elvin Lytle, Design Specialist, examine the AiResearch Condenser Fan used on the Boeing 707.

AiResearch Manufacturing Division of the Garrett Corporation, long a leading manufacturer of electro-mechanical components and air conditioning systems for aircraft, is a major user of KLIXON Inherent Overheat Motor Protectors.

Elvin Lytle, Design Specialist of AiResearch, selected a 3-phase KLIXON Motor Protector for use in this 10 HP electric motor driven condenser fan, a component of the vapor cycle air conditioning system on the Boeing 707 Jet Stratoliners ordered by American Airlines. In this application, the KLIXON Protector shuts off the fan motor if excessive inlet air temperature or inadequate air flow causes the motor windings to overheat.

METALS & CONTROLS CORPORATION
Spencer Division
3810 Forest Street, Attleboro, Mass.
KLIXON®

YOU CAN PROFIT BY USING GENERAL PLATE CLAD METALS

Ulanet Thermostats Value Continued Material Uniformity in TRUFLEX parts and assemblies

Model 28 Miniature Hermetically Sealed Thermostat extremely sensitive.

Here's another case history of a leading manufacturer who has found he can depend on parts made from General Plate's TRUFLEX thermostat metal. H. Ulanet, President of the George Ulanet Company, puts it this way:

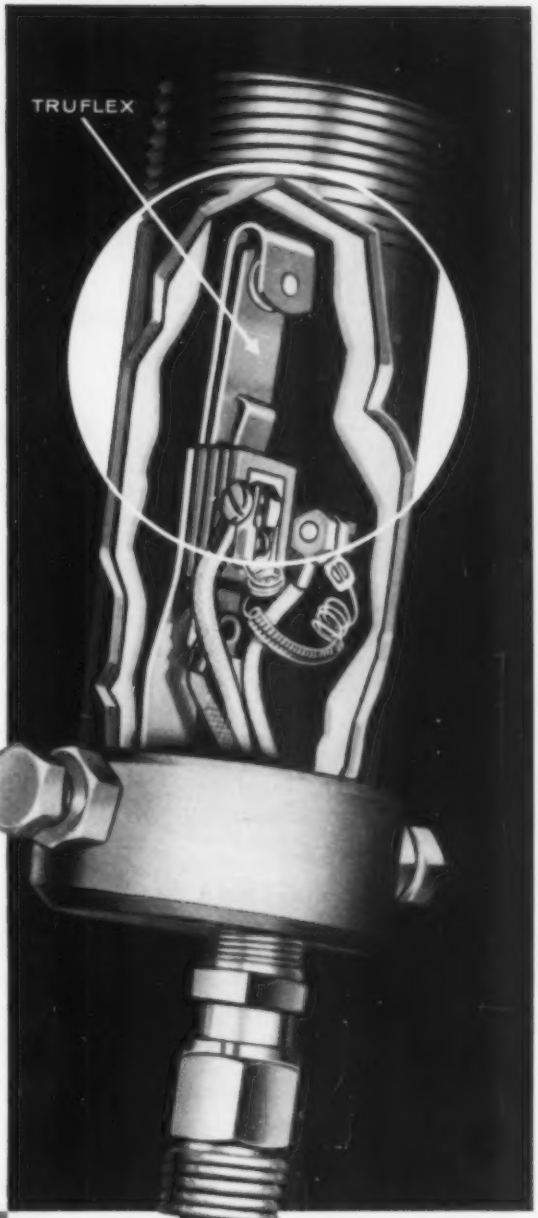
"Bimetal is a most important component in Ulanet Thermostats which have a world-wide reputation for quality. Therefore we must be certain of continued material uniformity and quality with each shipment.

"During our 22 years' experience with General Plate's TRUFLEX *thermostat metals we have found that they have met our exacting specifications."*

General Plate can supply dependable thermostat metal parts and assemblies for installation in your products, too. You'll get top performance because the high quality of each piece you receive is consistently uniform — an exact duplicate of the original.

General Plate TRUFLEX thermostat metal parts and assemblies are made to meet your specific needs for temperature range, electrical conductivity and corrosion resistance.

If you set up to make your own parts, General Plate can supply TRUFLEX thermostat metal strip to consistently meet your specifications. Send us your specifications for parts or strip — we'll be pleased to quote.



Specially Designed Industrial Thermostat.

A few typical Truflex formed parts and sub-assemblies.

You can profit by using General Plate Clad Metals!

METALS & CONTROLS CORPORATION

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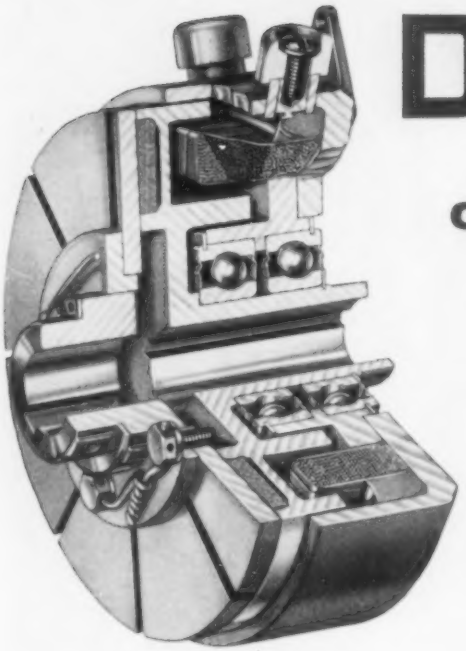
New—Small Sizes!

EATON DYNA-TORQ

MAGNETIC-FRICTION CLUTCHES and BRAKES

Now Available in a Full Line from 1¾" to 15" Diameter



STATIONARY-FIELD, BEARING-MOUNTED DYNA-TORQ CLUTCH

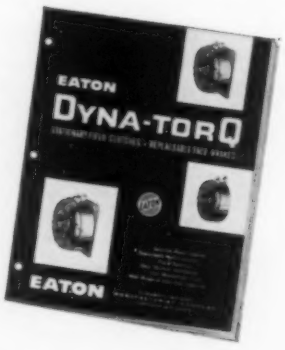
Eaton Dyna-torQ Magnetic-Friction Clutches and Brakes provide a simple, accurate, responsive method of controlling power and motion in today's complex production and processing machines.

The new smaller sizes and new design types of Dyna-torQ Stationary-Field Clutches and Brakes enable Eaton to offer a well rounded line, including flange-mounted and bearing-mounted clutches, and replaceable-face brakes. Unique features of design and construction result in worthwhile maintenance cost savings. Dyna-torQ units, easily and quickly installed on new machines or existing plant equipment, deliver many highly desirable advantages.

Dyna-torQ Magnetic-Friction Equipment Offers these Important Advantages:

- ★ Accurate power control
- ★ Dependable motion control
- ★ Rapid response
- ★ Easy "built-in" installation
- ★ Low maintenance costs
- ★ Compact plug-in type controls—may be remotely mounted
- ★ Inter-changeability of parts

Send for this new illustrated bulletin giving complete description and specifications covering Dyna-torQ Stationary-Field Clutches and Replaceable-Face Brakes.



EATON

Dyna-torQ Equipment is Available through Dynamatic Distributors in all Leading Cities

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DYNAMATIC DIVISION
MANUFACTURING COMPANY
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first in silicones

Dow Corning

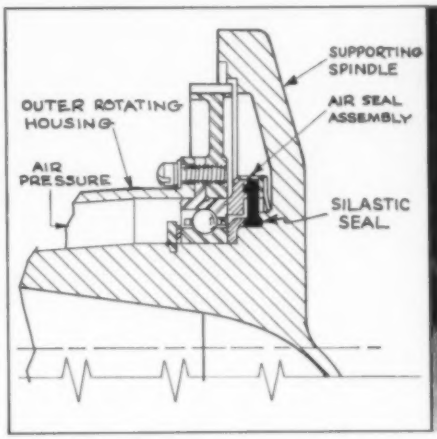
SILICONE NEWS

for design and development engineers • No. 55

INCREASE RELIABILITY OF MISSILES WITH SILICONES

Even a flight into outer space fails to lessen the elasticity of Silastic®, the Dow Corning silicone rubber. Proof is the continuing use of this material by Co-Operative Industries on their wave guide for missile guidance systems.

Co-Operative Industries has used a protective covering of Silastic on its WR-112 wave guide for over two years. This molded-on silicone rubber jacket protects the corrugated brass core from damage and helps to control flexing during preforming and installation. *(Cont. Pg. 2)*



OIL-RESISTANT SILASTIC SEALS HAVE 100 TIMES LONGER LIFE

Oil that makes most rubbers deteriorate rapidly has little effect on Silastic® LS-53, the Dow Corning fluorosilicone rubber. This has enabled Dalmo Victor Company, Belmont, Calif., to increase the life of air seals on its aircraft radar scanners by as much as 100 times.

Fitted against a rotating shaft, the lip seals must maintain a positive seal to keep the scanner's internal pressure at a constant level regardless of atmospheric pressure changes due to altitude. What's more, shaft speed is comparatively high, vibration is continuous, and operating temperatures range from 160 to minus 70 F.

Shaft and bearing lubricants caused original seals to swell and subsequently pull away from the shaft. Warping made it necessary to install new seals every time the units were disassembled.

To solve this costly problem, Cole Manufacturing Company, Palo Alto, Calif., made seals of Silastic LS-53 from existing molds. After 36 hours immersion at room temperature in MIL-L-6085 and MIL-G-3278, these seals showed no measurable change in dimensions. Other tests under actual operating conditions did not produce a single failure. The new seal assemblies were still in such excellent condition after 500 hours of operation that they could be reassembled with ease.

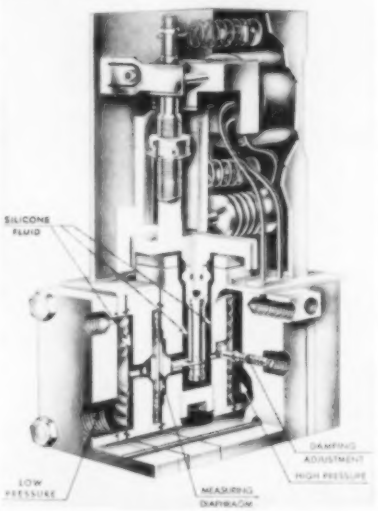
The assemblies are fabricated by Cole Manufacturing for Dalmo Victor Company by bonding Silastic LS-53 seals to phenolic rings. Silastic LS-53 has enabled Dalmo Victor to improve the reliability of its radar scanners while slashing its seal replacement costs to a tiny fraction of the former rate. **No. 560**

Get More Accurate Response with Silicone Damping Fluid

Effects of temperature on performance of instruments, controls and sensory devices are minimized when you design with silicone fluids. That was the experience of Fischer and Porter Co., in designing a differential pressure transmitter for exceptional accuracy over the temperature span of —20 to 250 F.

Accurate calibration of their d/p cell over the wide operating temperature span required a damping fluid with near-constant viscosity; a relatively low coefficient of thermal expansion; freedom from vapor pockets at elevated temperatures.

Fischer and Porter engineers found that a Dow Corning silicone fluid more than meets all of these service requirements. Immersed in the silicone fluid, the measuring circuitry of their 1500 psig-rated d/p cell gives rapid response to differential pressure changes without over-ranging and minimizes the effect of temperature on calibration to less than 1% per 100F. Another plus: non-corrosive, non-sludging silicone fluid assures minimum maintenance and exceptionally long service life for the d/p cell. **No. 561**



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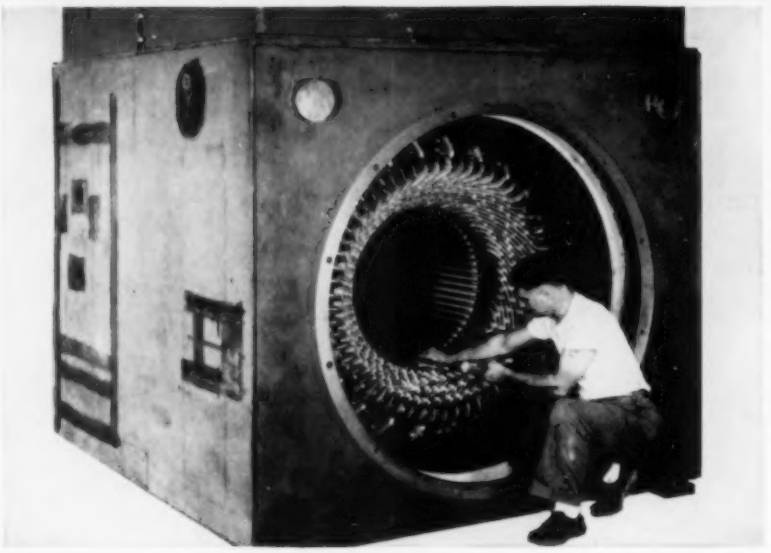

CON ED SPECIFIES SILICONES FOR BOILER FEED PUMP MOTORS

Some of the largest and most dependable electrical equipment ever built is insulated with Dow Corning Silicones for that extra margin of protection and performance. Among the latest examples are the world's largest 2-pole induction motors recently installed by Consolidated Edison Co., New York.

Built by the Elliott Co., Ridgway, Pa., these 6,000 hp motors are designed to drive boiler feed pumps at a power station. With maximum reliability virtually a "must", Consolidated Edison specified that the units be silicone-insulated to provide an optimum factor of safety against overloads, high ambients, moisture and other motor hazards.

The coils, comprised of silicone-bonded, double-glass-served magnet wire, are protected with tape made from Silastic®, the Dow Corning silicone rubber. Other insulating components made with Dow Corning Silicones include silicone-bonded, glass-backed mica tape; silicone-glass laminates; silicone-glass cord; silicone varnish; and silicone rubber pastes and compounds.

The result is a high-temperature insulation system where every component is temperature rated at 180 C (Class H) or better, assuring maximum reliability and minimum maintenance. *No. 562*

SILASTIC *(Continued)*

Exposed to both blistering heat and bitter cold during a missile flight, the Silastic jacket has repeatedly demonstrated its ability to resist the effects of ozone and aging while in a stressed condition . . . to remain soft and pliable over an operating temperature range stretching from —65 to over 500 F. The Silastic jacket also seals out moisture and cushions the units against shock and vibration, substantially increasing their reliability.

Engineers at Co-Operative Industries use Silastic in various thicknesses ranging from 1/16 to 1/4 inches. They report that Silastic is easy to process because it molds readily, forms well and conforms nicely to the short radius preforms and twists typical of wave guides. *No. 563*

new literature and technical data on silicones

Summary of Silastic Stocks and Pastes is an up-to-date compilation of information designed to help select the Silastic most useful in a specific application. Typical properties, and application and processing information, are presented in convenient table form for easy study and comparison. *No. 564*

Silicone Release Coatings for Paper is one of a series of articles from PAPER FILM AND FOIL CONVERTER. It cites the various uses for coated paper and paperboard and gives details about performance testing. Tables and graphs are included showing release characteristics against various sticky materials. *No. 565*

Dow Corning 330 Fluid is a low viscosity silicone fluid designed for use in electrical and electronic units. It is heat-stable, has excellent dielectric properties, remains pourable to below minus 100 F, and retains a relatively flat viscosity-temperature slope over a broad span. *No. 566*

Silastic RTV is a do-it-yourself silicone rubber that vulcanizes at room temperature. It enables you to make rubber parts on-the-spot for those applications where a heat cure is impractical or cannot be tolerated. Silastic RTV retains good physical and dielectric properties. *No. 567*

The application of Dow Corning 991 Varnish has been found to provide a most effective means of improving surface resistivity of printed circuits and electronic equipment that must remain operable under conditions of high humidity. *No. 568*

A list of distributors of silicone insulating components is included in a recently published selection guide. This illustrated, six-page reference is designed to aid you select the silicone insulating components that provide extra capacity to motors, generators, and dry-type transformers, and increase the reliability of such equipment. *No. 569*

In missile application, aircraft, or heavy duty industrial equipment, laminates made with Dow Corning laminating resins assure dependable service at high temperatures. They are lightweight, strong, and resistant to corrosive atmospheres. They retain excellent dielectric properties even under adverse operating conditions. Silicone glass laminates are available from a number of fabricators and manufacturers listed in . . . . . *No. 570*

Dow Corning Corporation, Dept. 8610, Midland, Michigan

Please send me: 560 561 562 563 564 565 566 567 568 569 570

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY ___ _____ ZONE ___ STATE _____

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DEVELOPMENTS

TO WATCH...

Thermally stable laminating resins . . .

. . . for use at temperatures to 800 F are being developed at Midwest Research Institute under Air Force sponsorship. These are silicone resins, chemically modified to improve their high-temperature strength and dielectric properties.

According to MRI researchers, laminates made with the new compositions (technically, they're disilyl compounds) and properly fabricated, show a bending modulus 25 to 50% greater than commercial materials; and one type at least shows a flexural strength of 18,000 psi after 30 min. at 800 F; while a comparable commercial laminate goes to pieces completely.

Progress reports on this research are contained in two reports to the Air Force (PB 131190 and 13175, available from the Office of Technical Services, Washington 25,) and a talk delivered by three MRI chemists at last month's ACS meeting.

New belting for mechanical drives and conveyors . . .

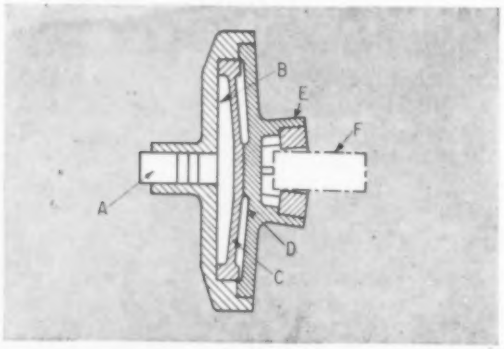
. . . now being readied for market by Ton-Tex Corp, Englewood, NJ., includes types with rayon, nylon and heavy-duty cotton duck centers, and nylon-covered belts for application where a smooth, low-friction surface is required. According to Ton-Tex, all have been thoroughly field-tested and are now ready for commercial application. They'll be offered in standard types and sizes.

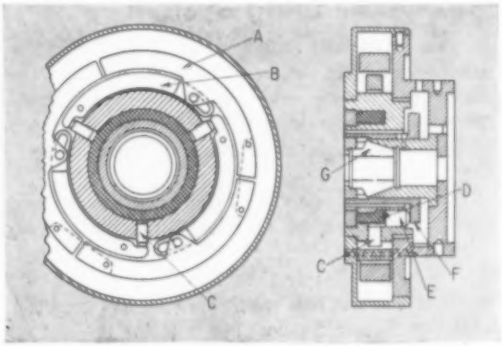
Hydrostatic chucking devices . . .

. . . with interesting features are appearing on both sides of the Iron Curtain.

One, from Britain, is a self-contained diaphragm-type that operates by internal hydrostatic pressure. As the assembly diagram (left, below) indicates, the chuck has two diaphragms, one of which carries the chucking ring and jaw pads, so that when the diaphragm is pressed outward, the jaws are opened. An axial piston *A* compresses the hydrostatic mass in chamber *B*, bulging an inner diaphragm *C* which, in turn, is pressed against a second diaphragm *D* attached to the split chucking ring *E*. As the diaphragm is pressed outwards, the ring opens, and the grip on workpiece *F* is loosened. Advantage, the designer says, is that a high clamping load can be applied with a system actuated by a very small stroke. Integral Ltd., Wolverhampton, makes it.

The other new chuck diagrammed below, designed in Hungary, also uses a hydrostatic material, but the prime actuator is centrifugal force. As the chuck turns, the weights *A* are flung outwards, turning the double-armed levers *B* which push the radial pistons *C* inwards. This compresses the hydrostatic material *D*, moving the axial pistons *E* and actuating the axial sleeve *F*. This, in turn, pushes the conical clamping sleeve *G* backwards, gripping the workpiece. Springs return the flyweights to their original position when the machine stops.





British chuck (above) features two diaphragms, operates simply by compressing the piston. Other is the Hungarian chuck. It uses both hydrostatic pressure and centrifugal force, but is so designed that flyweights will re-set themselves.

DEVELOPMENTS TO WATCH...

Non-petroleum lubricants can be given . . .

. . . a high degree of resistance to oxidation and radiation damage through use of sulfur and selenium inhibitors, say engineers from California Research Corp and General Electric.

They find oils made from alkyl aromatic compounds and protected by selenide inhibitors withstand at least 10^{10}r. Most conventional products solidify at 5×10^8 or 10^9r. They caution, though, that this combination may not be best for every type of service. "Materials effective as oxidation inhibitors in the absence of radiation are not necessarily effective in its presence," they note.

Injection casting . . .

. . . is called "an important technological breakthrough" that may offer a new way to produce parts in hard-to-handle metals.

As described by Argonne National Laboratory, the method uses special heat-resistant glass as the casting mold and combines vacuum and pressurized gas systems.

To produce reactor fuel "pins," for instance, glass tubes, closed at the top, are suspended above the molten fuel (uranium metal) in a vacuum chamber. When the melt reaches desired temperature, open ends of the tubes are submerged in the melt and the furnace is simultaneously pressurized with argon gas, forcing the metal into the tubes. It solidifies almost immediately; the tubes are then removed and the glass broken to free the castings.

Far-reaching changes in brake design . . .

. . . are being advocated by users of mobile equipment. While admitting that poor maintenance is responsible for many failures (*PE—July 21, p 21*) they note that brake design has remained essentially unchanged for some 25 years while average loads and speeds have skyrocketed. For instance, Consolidated Freightways engineers say "brakes and brake systems, as we know them today, are on the ragged edge of being inadequate. . . . The internally expanding brake is so designed that it is trying to rupture the brake drum from the very first minute it is put into service."

What to do? Either develop a new brake or find some way to reduce the load of the present one. The first alternative is obviously better; and Consolidated engineers offer these specific suggestions:

Ultimate development in the foundation brake, they say would be the opposing-shoe type. This could work on a disk, as does the spot brake, or on a drum. They prefer the disk brake idea, from a production standpoint at least, because it is simpler—no contour is necessary on the shoes. In the drum type, grinding the lining to fit the given diameter might pose production problems and would certainly increase costs.

They would also like mounting the brake on the outside of the wheel. This, they say, seems best from the standpoint of maintenance and cooling, and would be adaptable to nondriven axles. It would call for complete redesign of hub and wheel assemblies, but a spoke-type wheel could be used—perhaps in its present form.

New monitoring system . . .

. . . for controlling dangerous gases combines electronics, chemistry, and radiation. Being developed under AEC sponsorship, the system uses a radioisotope-exchange technique, based on known chemical reactions, to control a non-radioactive gas. Here's how it works:

The gas being monitored is allowed to pass over a bed of a radioactive chemical with which it will react with known efficiency. Then, effluent gas from this reaction is simply checked with a radiation detector to find out how much material has been converted, and therefore how much of the original gas was present.

To monitor sulfur dioxide (for air-pollution control), for instance, the SO_x-containing gas is passed over a bed of chlorine trioxide which has been formulated with radioactive chlorine. Chlorine trioxide is a solid material which is converted to chlorine dioxide, a gas, by reaction with SO_x. The effluent gas, then, contains radioactive chlorine atoms in direct proportion to the amount of SO_x that was present and is a reliable indication of the SO_x level in the original gas.

AEC Commissioner W. F. Libby predicts that, in addition to its application to sulfur dioxide and to dangerous phosphorus and arsenic compounds, the system may also prove useful as a tool for chemical process control. —ARG

Stepless Control Seen as Important Future Motor Development

SCHENECTADY, N. Y.—"Contactors in electric motor controls are becoming more and more archaic and we must make future controls without them," is the opinion of Philip L. Alger, consulting engineer of the Medium A-C Motor & Generator Dept of General Electric Co. A recognized authority in the field of rotating machinery, Mr. Alger, in assessing future developments in this field in an exclusive interview with PRODUCT ENGINEERING, also said that the gas or air bearing will find only limited use in motors, and that overload margins will be reduced if higher temperatures are used to increase the horsepower rating of the motor. Some of his other comments:

• What role will insulation play in future motor developments?

"Silicone rubber is the most promising insulating material to come along. It has good elastic properties, is good at high temperatures and against corona. With its ability to assume various stiffnesses and shapes, it will become very useful when we learn more about working with it. It will make possible motors with higher operating temperatures if we want them.

"But these higher temperatures are not a virtue. A hot motor causes more copper losses, expansion and contraction and bearing problems. Furthermore, we're not going to move into this high-temperature bracket fast; we're going in that direction gradually."

• Will there be special insulations?

"We cannot afford to spend much more for special high temperature insulation. If such a material is going to come in, it will be because it is feasible at a cost comparable to present insulation costs. By the same token, we cannot expect to have any universally standardized insulation because there is no one material available that is good for all problems—salt, heat, acid, dust, etc—at a low cost.

"Motors won't use only standardized insulation materials. Such standards are only possible to a degree. For no matter what you might do in that direction, the competitors will offer something different to try to get the advantage. Many customers will be appealed to by that approach, so you will have to change your design also.

"At the present time we are especially interested in getting motors that are sealed against carbon dust and water, and that have the ability to take emergencies and go into hot places. Another problem of present interest is how to completely avoid corona, or make it harmless."

• Will overload capacities be increased?

"If a motor is rated at 50 hp, that means in American parlance that the motor is capable of carrying 60 hp for a long time and 75 hp momentarily, plus a maximum torque guarantee of 200% or more of rated torque. The German motor standards specify a maximum torque of 160% of rated torque. Such a motor would lie down and die on US overloads, because it would get too hot. American practice is to have overload possibility designed into the motor, and enough margin of extra torque to take care of low voltage, misapplication, or what have you.

"Indications are that we won't jump over to the European scheme of things. Rather, we will come closer together and accept somewhat lower overload margins, because we are more and more economically minded. The increased demand for class B motors is evidence of this. Since it is possible to make class B motors with Alkanex or enamel wire in almost the same dimensions as a class A motor with just a slight increase in cost, we can expect more of a trend to class B motors. In deciding the standards for the new class B insulated motors, NEMA has retained so far the usual 15% overload margins, but the tendency will be to reduce this if still higher temperatures are adopted. Unless we agree to cut down permissible overloads, it will be necessary to continue to have motors that run cool at full load just to allow room for increased temperature for overload operation."

• Will motors get smaller?

"A little, and thinner insulations, of course, can be expected to help reduce the size. The problem is in making a balanced design. There must be enough space for air—with high enough velocity for a good job of cooling, and enough stiffness to keep noise and vibration down. We have made good progress in making the motor more compact. We are now able to get more air through less space by using the space more efficiently. One thing industry is looking for in larger motors is one that doesn't sound like a siren when the cooling air comes out of the cooling ducts. Now, with a better understanding of acoustics, we can increase the velocity of the air through ducts with less noise."

• What are some of the bearing developments?

"We are trying to standardize as much as possible on ball bearings. The ball bearings take thrust nicely, but they have a natural limit of speed and size. Beyond that, sleeve bearings are necessary.

"The most significant bearing development is the water bearing. On this bearing, we can now carry 20 times the load that we carried not long ago. The water film may be only ½ mil thick at high pressures. In a high pressure bearing, oil is the natural choice because of its thicker film. However, with water bearings we can do very well by using the right materials, by shaping the bearing, and by control of the flow of the liquid so that it covers the face correctly.

"Liquid bearings have a much

greater load capacity than ball bearings. With the right liquid you can carry any load that you desire. The thickness of the film depends upon the viscosity and the speed of the oil. We are learning now how to make thinner films and consequently smaller and more efficient bearings, but the whole program will be a slow evolution.

"Gas is the next stage, but it will require a very high gas velocity to get a thick enough film in order to carry a significant load. Actually, the air bearing is just an interesting extension of the line. It never will be anything basic for wider use because it has too thin a film and is too delicate to make it practical for ordinary use. I expect that the gas or air bearing will be limited to a special use like gas turbine driven generators to power aircraft auxiliaries.

"Tungsten carbide is attractive for bearings. On a shaft with a given load, it will deflect about half as much as steel. While materials with a high elastic limit such as this are good for both sleeve and ball bearings, they are expensive, hard to machine, and generally haven't found enough advantage to warrant the effort to make them go. The material can be used, but only for special applications. As for plastics, they are not a vital part of our story.

• What new trends in controls can be expected?

"Contactors are becoming more and more archaic and we must make future controls without them. We're giving a lot of study to applying contactorless controls to wound-rotor motors in such a way as to permit the motor to be used over a wide range of speed and torque for almost any purpose. The demand is growing: motor users don't want stepped control, contactor noise, or maintenance.

"A new stepless ac crane control announced by General Electric just last week is an example of this type of product. Reversing is possible by either static control equipment or with contactors. Stepless speed regulation is provided without the use of a mechanical or electrical load brake. Creeping loads are possible in both directions, to bring the load to a standstill without setting the holding brake or removing motor power.

"Another problem is in a steel mill where wire brushes are used to clean steel strip. To keep the steel bristles from wearing to a taper on one side, the motor must be reversed every two minutes indefinitely. Formerly, seven control steps were required to get the motor up to full speed in both directions. The contactors would last a few weeks. Now, we are recommending stepless operation.

• Are direct-current motors coming back into favor?

"The new silicon rectifiers will lead to many vital changes affecting the use of dc motors. This motor is becoming more versatile and more widely used. For example, there is a growing use in industry of dc motors operated from rectified ac with either voltage or field control, or both. But the commutator, brushes, and maintenance problems are still a disadvantage. Cost is still high because of these things."

• What education is needed in the power field?

"There are very few power students in any of our engineering schools nowadays, partly because the art of teaching power subjects got behind and 'frozen in.' Also, the war came along and demanded new things—radar, atomic energy, missiles, aircraft, electronics—and all the young people are going into these fields. People in the power field are now looked upon as old-fashioned dodoes. The professors couldn't keep up with the state of the art and the students lost interest. We ought to teach electric machinery merely as an example of an energy conversion process. Then, the borderline in automation between electronics and physics will be gone and we will end up teaching engineering as a whole, with power as an example.

"When I retire from General Electric the end of this year, I will become a Professor at Rensselaer Polytechnic Institute. My efforts will be directed towards showing students the still adventurous nature of power engineering."

Plan Science Meeting in Washington

WASHINGTON—An International Conference on Scientific Information will be held in Washington on Nov. 16-21. It will be sponsored by the National Academy of Sciences; the National Research Council; the National Science Foundation and the American Documental Institute.

Panels of scientists will discuss such items as: requirements of scientists for scientific literature and reference services; function and effectiveness of abstracting and indexing services for storage and retrieval of scientific information; new techniques for handling scientific information, etc.

Trim 88-lb plastic body . . .

for a two-seater sports car is being molded by Vibrinplasticarr of Rome, Italy. Luigi Crispoliti, company owner, predicts that the present body weight, which includes seats and fittings, may be shaved to 23 lb by a new and undisclosed production process. Basic material for the car's body is Vibrin plastic, a polyester resin produced by both Edison and Montecatini of Italy. Crispoliti forms the light-weight shells in a one-piece lamination. The car is fitted with a 750-cc competition Siata engine. Reports are that the car has stirred sufficient interest in Italy for Fiat to order the plastic shell for that company's 500-special sports model.

Salt Water Goes Fresh As Pilot Plants Test Conversion Theories

WASHINGTON—Spurred by financial support given through the Saline Water Act of 1952, several promising processes have reached pilot stage. And though no major breakthrough's have been scored yet, many technical problems are being solved.

Promising conversion concepts are based on distillation, membranes, and freezing. (*PE*—Oct. 7, '57, *p* 23) Here is the technical status of current projects as viewed by W. S. Gillam and J. J. Strobel of the Office of Saline Water, Dept of Interior.

A pilot version of the Hickman Still has been installed at the International Nickel Co's test station, Wrightsville, NC. Tests will measure mechanical and process functioning of the still, and scaling and corrosion problems in actual operation. Lab models of the still have shown heat transfer coefficients of 3100 btu/ft²/deg F/hr. The Wrightsville test will tell whether or not these coefficients can be equalled or possibly surpassed on a pilot scale.

W. L. Badger & Associates betting that a long-tube vertical evaporator is potentially the most economical of the commercially available evaporators, have set up a seven-tube test unit at the International Nickel Co test station at Wrightsville Beach, NC. The unit is testing tubes made of seven materials—mild steel, aluminum, aluminum bronze, aluminum brass, admiralty metal, 90-10 cuprometal and copper—and will show whether corrosion and scale can be controlled with these low cost materials. Two techniques for controlling corrosion are on trial: one is adding an acid to control hydrogen ion concentration, the other a sludge for precipitating scale-forming salts. In the latter case, theory predicts that scale-forming salts will precipitate on their own kind rather than on a foreign surface. Test evaporators are full size so that data will be applicable to plant design.

OSMOSIS HAS SEVERAL VARIATIONS

Of four promising membrane processes, electrodialysis has reached the stage where a few commercial units are available. The tests indicate that power required for pumping is a substantial part of total power requirement. About 7 kwh is needed to remove 1000 rpm of salt in 1000 gal water. Equipment is fabricated in the US by Ionics, Inc.

The osmionic process is new and similar to electrodialysis except that it requires no outside electric power or electrodes. A large prototype is about complete. Tests on it will show whether demineralization proceeds as fast as design equations predict and whether the rate is fast enough to be of practical interest.

In reverse osmosis, ion-resisting membranes—of, cellulose acetate—reject up to 99% of ions in solution but allow relatively pure water to pass. Membranes now available do not show sufficiently high flow rates or durability for practical application. Study of the mechanism of ion resisting membranes at the University of Florida, may produce improved films.

CARRIER SETS FREEZING PACE

Carrier Corp is developing equipment for freezing and evaporating salt water to get fresh. Preliminary designs for a pilot plant are underway on the basis of experimental work that overcame two obstacles: design of equipment for removing brine from ice crystals with a minimum loss of fresh water, and design of a freezer.

US Nears Clear Definition of Technician

WASHINGTON—The difference between a technician and vocational training student is defined by the newly-enacted National Defense Education Act of 1958, says the National Society of Professional Engineers.

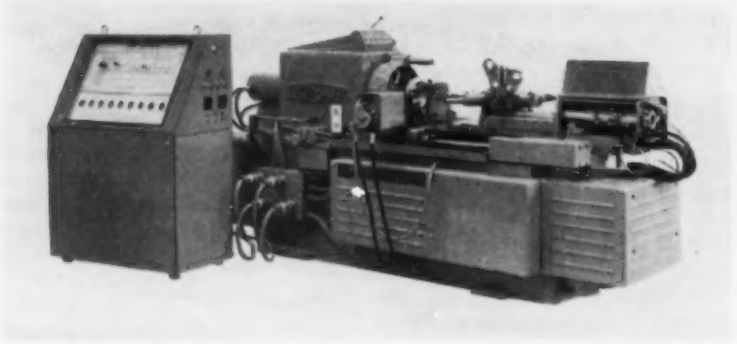
The law provides an additional $15 million annually to expand present vocational education assistance programs, operated heretofore through state agencies. However, the law states that the additional money is restricted to use for "training of individuals to fit them for employment as high skilled technicians in recognized occupations requiring scientific knowledge as contrasted with vocational school students."

Dept. of Labor now defines a technician, engineering sciences, as "one performing specific functions which are specialized parts of scientific or engineering activities, utilizing the underlying scientific, engineering and/or mathematical principles related to the specialized field of work, and applying established techniques and methods toward solution of practical problems encountered in the field of specialization.

Specific functions, though they may vary, are confined to (1) research, design, development or construction of products or structures, (2) exploration, measurement, analysis or applications of basic scientific concepts, and (3) control of production facilities and manpower.

In order to adequately perform these functoins, the individual would need at least 2 years training in a technical institute, or equivalent on-the-job training, Dept. of Labor says.

Dodge Royal Lancer . . .
will feature a variety of driver conveniences: pushbutton controls for heater and air-conditioner; electronic rear-view mirror to automatically cut glare from overtaking cars; a high steering-wheel flattened at top for wider road vision; and swingout swivel seats. Engine for the Royal Lancer rates 295 hp at 4600 rpm and has displacement of 361 cu in. with 10.1:1 compression ratio. For its economy Coronet series, Dodge is providing a Red-Ram V-8 engine designed for fuel economy. This engine has 326 cu in displacement and 9.2:1 compression ratio. Economy features in the Red Ram engine, company sources say, include an axle with a 2.93 ratio for reduced engine speed, and a three-stage automatic choke to cut gasoline use during warm-up.



Rapid set-up . . .
is combined with automatic operation in much French tool design. The Codimatic lathe, a typical example, is programmed in a few minutes by plugging pegs into control unit. Pegs set up circuits that control electrically operated hydraulic actuators of a six-position turret, two independent carriages and the elecromagnetic clutch in the spindle gearbox. Programming is simplified by grid layout of begboard. Vertical lines represent end of in-and-out strokes for each element, and horizontal lines repersent "start" stroke for each element. Cycles are set up by putting pegs in appropriate intersections. Spindle speeds are set on dials. Pegs at bottom of vertical lines determine spindle speed changes. Pegs also govern feed combinations. Approach and feed length is set on lathe by adjusting switch stops. Once cycle is set up, operator only puts work in chuck and removes finished piece.

Display Automatic Tools at Paris Trade Show

PARIS—Exhibits ranging from hand tools to Renault's 70-ton line of transfer machines highlighted the Mecanelec show held in the still unfinished exposition palace on the outskirts of Paris. Exhibits showed that ceramic tools are gaining favor among manufacturers, particularly in the auto industry. A manufacturer of aluminum oxide ceramic tool bits reports sales of 7000 per month. The Sculforth "Supercap" lathe was in operation with ceramic bits during the show, making finished cuts on cast iron at better than 2000 ft per min. The lathe has a 40-in. swing, 50-hp motor with a top spindle speed of 1600 rpm and is made by Sculfort-Fockedy, Vautier & Co.

Automatic transfer machine . . .
by Renault was a hit of the show. Designed to machine cylinder-head castings for diesel engines, the line is made up of 20 work stations and 10 control stations that perform about 300 machining operations. Work carriers are returned automatically to loading stations. Capacity of the machine is 30 cylinder heads an hour, and, the machine can handle either three or two-cylinder heads. Changeover is made by removing 25 of the 250 tools in the transfer machine and adding 19 others. Three two-position spindles must be reindexed, and adapters are added to the carriers. Berliet, a French truck manufacturer, gets the machine at a price Renault says is below comparable US equipment.

Templet contour attachment . . .
shown here on a Gambin miller, can be adapted to other makes of milling machines as well. Used to produce turbine blades, the assembly has cut machining time from 20 to 4 min per blade.

Bits and Pieces

New procurement policy . . . of the Air Force, due out any day now, will reportedly force the big prime contractors to pass more work on to the subcontractors. In the shift to missile production, prime contractors have been doing more and more subcontract work themselves. Air Force, however, wants more of the work spread around. The idea is to keep a nucleus of plant capacity and skills in being, particularly where prime contractors use government facilities.

Minute quantities of acetylene . . . in air—important for studies of anti-pollution control—can be detected and measured by a fast, accurate colorimetric method developed by National Bureau of Standards. Quantities 10 parts per billion are absorbed onto the silica gel surface which is treated with ammoniacal cuprous chloride to determine amount of gas absorbed. This produces color change indicative of original acetylene concentration present in the air.

Generators rated at 800,000 kva . . . by 1970 are predicted by the AIEE and the ASME who report that many of the developments to make such generators possible are well along in the development stage, and others have been planned.

An auto exhaust law . . . within Los Angeles County is being planned by the local Air Pollution Control District in anticipation of a control device to combat auto exhaust. The APCD has set up a project committee to investigate problems of installation, inspection and enforcement preparatory to the engineering breakthrough.

US' largest solar furnace . . . expected to produce temperatures up to 5000 F and capable of intensifying ordinary sunshine into temperatures approaching those generated by a nuclear blast, was put into operation recently at Quartermaster Research and Engineering Command, Natick, Mass.

Chevrolet's Impala sport sedan . . .
for 1959 has added a second universal joint in the steering column. It is of the yoke and trunnion type, with the trunnion a molded assembly of fabric laminations impregnated with rubber. Highway vibration is absorbed by the trunnion, and handling of the car is improved with an increase in the steering ratio to 28 to 1. The conventional coil spring suspension at the rear has been refined by replacing the integrated 1958 upper control arms with two special members. One is a curved over-riding member, pivot-anchored at the ends to the frame and banjo housing of the axle, and a lateral control bar connects the right side of the axle housing to the left side of the frame. This allows the unsprung mass to oscillate with a minium of lateral reaction to the frame. Brake lining area has been increased by 27%, and front brake shoes are ¾ in. wider and the rear shoes are ¼ in wider. V-8 horsepower ranges from 185 to 315.

COMING EVENTS

OCTOBER

13-15 . . . American Institute of Electrical Engineers, 10th Annual Machine Tool Conference, Statler Hilton Hotel, Hartford, Conn.

14-16 . . . American Society of Mechanical Engineers and American Society of Lubrication Engineers, Lubrication Conference, Hotel Statler, Los Angeles.

16-17 . . . The Magnesium Association, Annual Convention, Fort Shelby Hotel, Detroit, Mich.

18-21 . . . American Society of Industrial Designers, 14th Annual Design Conference & Meeting, Bedford Springs, Pa.

20-21 . . . Institute of Radio Engineers, 4th National Aero-Com Symposium, Hotel Utica, Utica, N. Y.

20-24 . . . National Association of Corrosion Engineers, Annual Conference and Exhibition, South Central Region, Roosevelt Hotel, New Orleans.

20-24 . . . Society of Automotive Engineers, National Transportation and Diesel Engine Meetings, Lord Baltimore Hotel, Baltimore, Md.

22-24 . . . American Vacuum Society Inc., 5th National Vacuum Symposium, Sir Francis Drake Hotel, San Francisco, Calif.

23-25 . . . National Society of Professional Engineers, St. Francis Hotel, San Francisco, Calif.

26-29 . . . American Gear Manufacturers Association, Semi-annual Meeting, Edgewater Beach Hotel, Chicago, Ill.

27-30 . . . American Institute of Mining, Metallurgical and Petroleum Engineers, Annual Fall Meeting, Center Hotel, Cleveland, Ohio.

Improved Atmospheric Equipment Needed For Manned Space Flight

DALLAS—Equipment to keep an artificial atmosphere travelling along with man as he soars off into space flight is expected to result from current experiments, says a noted survival specialist. The deciding factors in designing the special "air conditioning" will be weight, space and power conservation.

Dr. Webb is Chief of the Environment Section, Aero Medical Laboratory, WADC Wright-Patterson AFB. His report was given during a panel discussion, "Man in Space," at the recent Air Force Association Convention here.

Creating the portable atmosphere needed for space flight, he explained, differs from our experience with balloon gondolas and experimental chambers in laboratories and submarines. Although main function of the space-flight artificial atmosphere is respiratory, the minimal gas pressure must also be maintained around the man, as well as a specified amount of nitrogen. Other requirements are no less critical.

The special atmosphere, Dr. Webb pointed out, must remove heat and water vapor constantly produced from the man, or the thermal imbalance that develops may bring death. Then the atmosphere must go on through reconditioning equipment. Also, odors and various other waste products from man must be removed.

Abnormal external conditions include low-gravity condition—which calls for new kinds of circulating blowers and heat exchangers—and for special design of liquefied-gas converters, if they are used.

A big problem is balancing heat generated within the isolated atmosphere—preventing too much gain from solar radiation, and excessive loss of heat to the void of space. However, the vacuum of space will be useful too—it will receive wastes and "purge" spent chemicals used for conditioning the artificial atmosphere.

A simple and compact apparatus for supplying a man in a sealed pressure suit, or small sealed cabin, for 12 hours has already been designed. It weighs about 50 lb and measures 2 ft

by 2 ft by 8 in. It supplies oxygen and pressure, removes carbon dioxide, carries off the man's heat and water vapor, and provides enough cooling to keep him in good condition when external heat is high. Two other systems—born of the 12-hr system—have been also designed to support a man for 48 hr.

For a longer mission, involving months and years, a completely self-sufficient, closed ecological (environmental relationships of human organisms) system is needed—probably some derivative of today's research in algae, Dr. Webb said.

Design must consider a variety of methods, Dr. Webb said. "Our present systems get heavier with time because of the stored oxygen and water, and the non-renewing chemical absorbers used for removing carbon dioxide. In a system designed for 10 or 20 man-days, water must be conserved and recycled, and a way found to dump carbon dioxide into space. Flights involving more man-days will need to conserve oxygen by recycling at least some carbon dioxide back into oxygen."

The limited techniques available for studying an isolated animal, plus the severe weight restrictions, pose serious design problems to the instrumentation engineer, reported Capt. C. H. Kratochvil, School of Aviation Medicine, at the Randolph Air Force Base.

"Two types of measurements can and need to be made—environmental data and physiological data," he said. This information must cover: cabin temperature, total pressure, oxygen and CO_2 partial pressures and the acceleration profile, heart rate, blood pressure, respiratory minute volume, electrocardiogram, oxygen uptake and CO_2 output. Relative humidity is desirable but not mandatory.

The mass and complexity of present devices precludes their use in the first space-flight vehicles. Capt. Kratochvil said that a lightweight oxygen sensor operating on polarographic principles has operated successfully for over 15 days. It is believed this can be modified to measure the CO_2 partial pressure. A small demand regulator has been modified to provide oxygen as the pressure in the capsule drops with oxygen consumption. Using a modification of the hot wire thermocouple, a resistance-free flowmeter measures the respiratory minute volume.

READER TO EDITOR

Pantograph Principle

To the Editor:

My attention was drawn to the article (Sept 15, p 99) illustrating "13 Handy Lever Mechanisms." This is an interesting review but I am calling your attention specifically to illustration No. 9 showing a pantograph principle. Unless I am entirely mistaken, in a precision reduction of a contour by this means, the three points, fulcrum, tracer point and scribing point, should lie in an exact straight line. Otherwise a distortion of the original contour will result.—Malcolm K. Parkhurst
New York 51, NY

• But for the application mentioned, extremely accurate positioning or control on assembly, it is okay as illustrated.—Ed.

Torsion Bars Abroad

To the Editor:

I offer you the following comments on Mr. R. S. Elliott's letter concerning British cars, "Torsion Springs Not New" (Sept 1, p 26).

Suspension and transmission systems have remained entirely conventional and there have been no major changes since 1950. The Hotchkiss drive is standard and torsion-bar springing, which was introduced largely with the Morris Minor in 1948 and used on many British Motor Corp models, has not subsequently been adopted elsewhere.

The large sports car made by the Bristol Aeroplane Co, with hand-beaten panels, is used largely to adorn sales pictures of the company's Britannia airliner and costs about as much. Torsion bar springs are used on racing cars such as the Aston Martin. They were used on Daimlers, Jaguar and Armstrong Siddeley Saphire cars but have now been dropped again on most models. All are in the upper-price bracket and together represent a trifling percentage of the total British car production. Vauxhall stopped using them in 1950. There are no others. No application represents a design change either.

—John Tunstall
London Editor
Product Engineering

2-piston Cylinder

To the Editor:

Under the heading, "Why Don't They Research and Develop?" (Sept 8, p 50) Mr. G. Halevi suggests a 2-piston cylinder offering independent, controlled motion from each of two piston rods. In July 1956 I designed and developed a marine engine reversing control. The equipment was installed on some of the new Sydney, Australia harbor ferries.

My design consists of a double air cylinder operated at 80 to 100-psi air pressure. The right-hand piston rod represents the pivoting point of the cylinder. The left-hand piston rod is coupled to a rack which runs parallel to the cylinder and in turn engages a pinion. The pinion is keyed to the end of the cam-reversing shaft of the marine diesel engine and replaces the hand wheel. The cylinder consists of two end caps and one center block. The cylinder is held together by four tie rods of which one is used as a guide bar through the cylinder guide block. The center block has two air connections—one for the right hand and one for the left-hand halves of the cylinder.

The idea is to control the ferry from the bridge by means of a 4-way air valve operated through a lever similar to the existing "Forward", "Stop" and "Reverse" lever, without additional manpower at the engine.

—Michael Dimitrov BSME
The Stearns Roger Mfg. Co
Denver, Col.

Brainstorming

To the Editor:

As one of the points in your editorial, "The Elusive Idea" (May 5, p 19), you mentioned a study made at Yale University on brainstorming. What is the name and source of the report, or paper in which this was published?

—W. R. Kelley
General Electric Co
Johnson City, NY.

• For Mr. Kelley and other readers interested in this study, contact: Mr. Steve Kerzerian, Director, Yale University News Bureau, New Haven, Conn. Ask for release No #253.—Ed.

Requirements Restated

To the Editor:

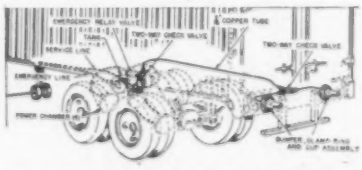
In your article on universal couplings (Aug 18, p 80) it is stated, "The forks must be assembled so that they will always be in the same plane." This is not the general case, but a special although common case. The general requirements may be stated: With the planes of the crosspieces perpendicular to the intermediate shaft, the input and output angles must be equal. —Byron M. Robinson
Sutton Engineering Co
Bellefonte, Penna.

Automatic Brake Actuator

To the Editor:

In one of your recent issues (Aug 11, p 50) there is a suggestion by Mr. B. E. Williams that someone should produce "an automatic brake actuator to be placed at the rear of large trucks and semitrailers. The brakes would be automatically applied at the contact of actuator and loading dock."

Last year our engineers developed a system, for precisely this purpose, which we



are now in the process of investigating. Sketch shows how this system functions.

—F. A. Ryder
Manager
Commercial Products, South Wind Div
Stewart Warner Corp

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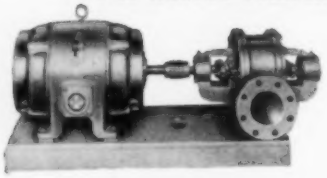

boiler feed
condensate return
hot and cold liquids
chemicals
refrigerants, etc.

Up to 200 gpm., pressures to 900 ft. High pressure at normal operating speeds. Handle widely varying heads with little change in capacity. Sizes 1¼" through 2½".

F-M BUILTOGETHER CENTRIFUGAL PUMPS

hot and cold liquids
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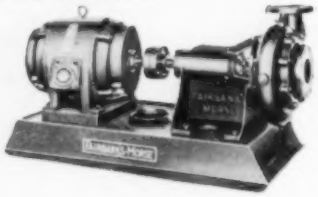
cooling towers, etc.

Up to 900 gpm., pressures to 525 ft. Close-coupled pump and motor units mount horizontal, vertical or angular. Sizes ¾" through 5".

F-M NON-CLOG PUMPS

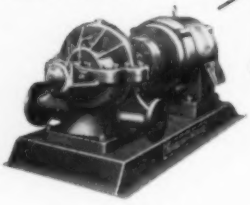
plant waste
slurries
paper stock
fruit
fish
vegetables, etc.



Up to 30,000 gpm., pressures to 175 ft. Sizes 2" through 20". Vertical or horizontal. Bladeless or conventional.

F-M SPLIT-CASE CENTRIFUGAL PUMPS

water supply; plant service
booster; circulating
air conditioning
refrigeration
chemical liquids
boiler feeds, etc.



Up to 50,000 gpm., pressures to 700 ft. Sizes 1½" through 36". Single stage or multistage.

The best-laid plans can go astray when mechanical equipment fails to deliver according to expectations or fails to give sustained peak performance. That's why Fairbanks-Morse builds something extra into all pumps so your plans work *as specified*.

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Full-rated capacity guaranteed...with built-in safety margin to assure maximum efficiency under most severe use. Rugged, durable, precision-made to maintain efficiency with minimum service.

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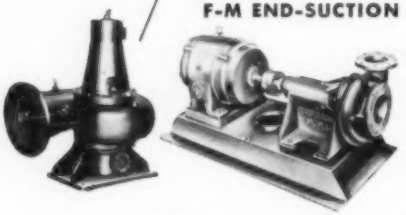
F-M Engineers are ready to work with you on any of your pump problems.

F-M END-SUCTION PUMPS



hot and cold liquids
chemicals
circulating liquids
low-viscosity liquids
cooling towers
condenser circulation, etc.

Up to 100,000 gpm., pressures to 250 ft. Sizes ¾" through 54". Horizontal or vertical.

For full information about Fairbanks-Morse pumps, call your F-M Sales Engineer or write Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago 5, Ill.

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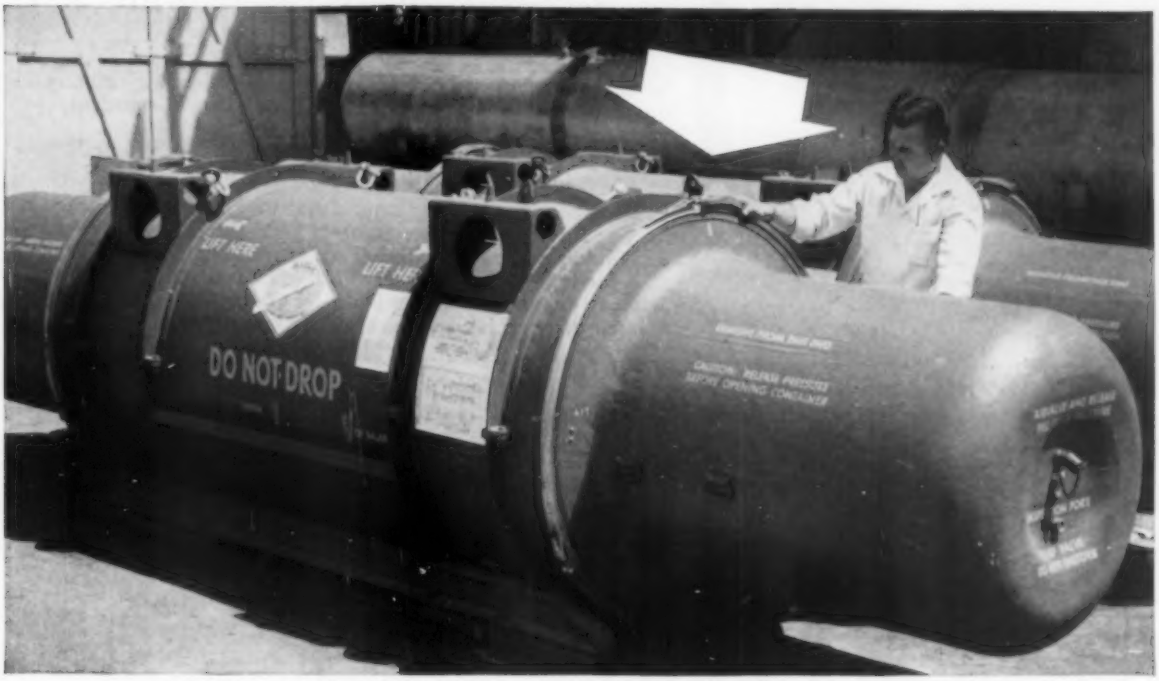
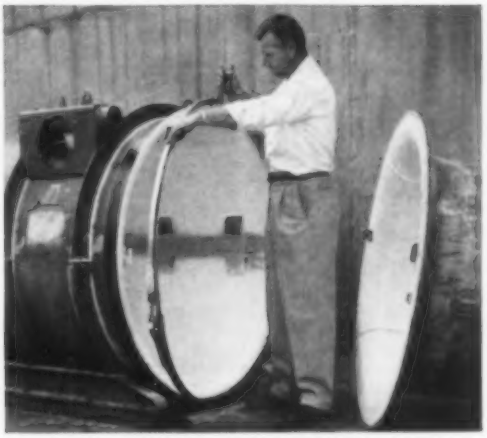
MARMAN V-Band Couplings Simplify Design of Pressurized Storage Containers



These fiberglass containers, connected by Marman V-Band Couplings, weigh 50% less than standard containers.

Lightweight storage containers designed for the Navy by Harbor Boat Building Company can be sealed tight and pressurized, yet opened instantly. Made of fiberglass, the container sections are joined and sealed with large diameter Marman V-Band Couplings. An over-center toggle latch on the coupling permits quick connection and disconnection without removing nuts or bolts.

Simplify your design requirements for sealing containers and connecting tubing and piping. Specify Marman V-Band Couplings. Available in standard styles or made to your choice of size, material and latch assembly. Write today for full information.



Over-center toggle latch on the Marman V-Band Coupling permits quick, easy opening of a sealed container.

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BEARING TIPS
by McGill

McGILL *CAMROL*® bearings cost less to increase efficiency of cam follower, guide and support roller applications

Using CAMROL CF and CYR (cam yoke roller) bearings eliminates the inconvenience of obtaining and processing component parts for built up followers. It costs less to select the proper size CAMROL bearing from stock than machine and assemble loose bolts, bushings, bearings, and snap rings.

CAMROL bearings are engineered and precision built to carry heavier loads with greater accuracy and alignment. An extra heavy outer race with full roller complement on a flanged stud (or inner for CYR) offers high load and shock capacity. Smooth, dependable action with low starting friction is assured through longer machine life. Available sealed also.

Improved performance, reduced friction and greater accuracy as ram guides in huge welder

The long ram stroke and large diameter welding wheel impose severe requirements on the CAMROL equipped ram guiding device of this resistance seam welder manufactured by the TAYLOR-WINFIELD CORPORATION. The CAMROLS provide greater accuracy with less friction than was experienced with a round ram and bushing type bearing formerly used. Lubrication is simplified, maintenance reduced and performance is excellent.

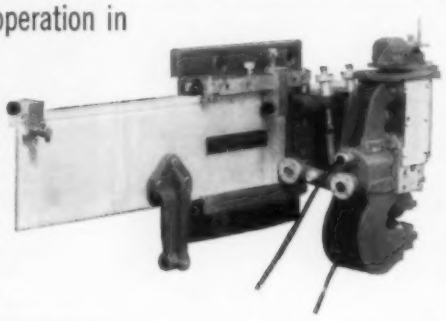
The welder has a throat depth of 84" and a 12" vertical stroke of the upper ram carrying the large diameter welding wheel.

CAMROL® bearings take severe impact loads in hydraulic snubbing hooks

CAMROL CF bearings are used as hook positioner rollers in BYRON JACKSON HYDRAPLEX HOOKS. These heavy-duty (100-150 ton capacities) hooks are used in oil well drilling work. The hook positioner mechanism includes CAMROL cam followers that travel on a hardened cam track when the load is released to return the hook to its original position. The CAMROL bearings take severe impact loads in the thousands of pounds.

Ease of assembly and smooth operation in electrolimit continuous gage

PRATT & WHITNEY CO., INC., manufacturers of the ELECTROLIMIT CONTINUOUS GAGE shown here have cut costs through the elimination of built up followers requiring ball bearings, shafts, spacers and milling slots by using sealed CAMROL bearings. They are prelubricated and protected. The CAMROL bearings which travel along a vertical cross slide rail, provide smooth, easy action as the gage slides onto strip material running through the mill. No bearing replacement reported in over 10 years.



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MULTIROL — GUIDEROL — CAMROL

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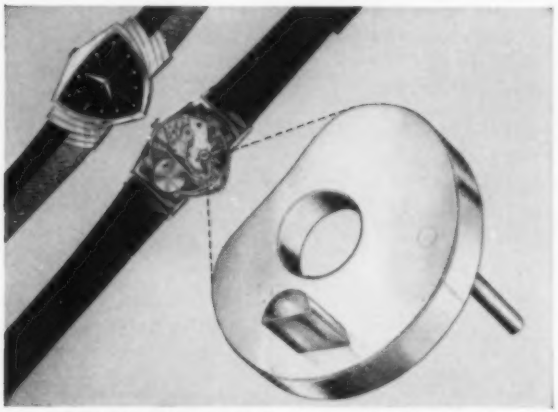
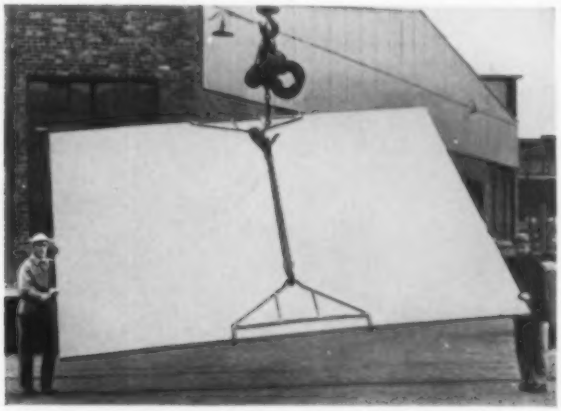
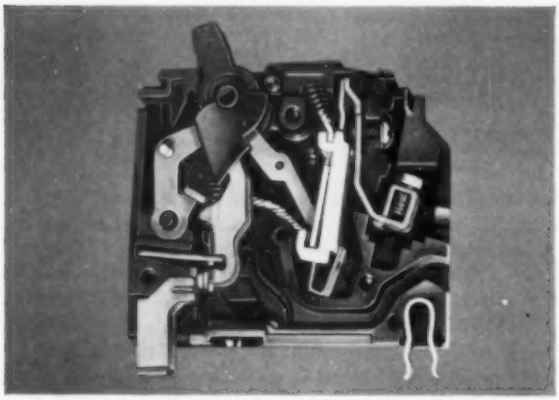
1/7000 OF AN OUNCE or 7 tons. In metals, it's the right combination of properties that counts. So just specify the properties you need. You may find the answers from Anaconda very interesting.



HAMILTON WATCH CO., for the world's first electric wristwatch, demanded these qualities in metal for a vital 1/7000-ounce indexing roller – high hardness and tensile strength; ease of blanking, machining; nonmagnetic properties. Anaconda Ambraloy-901 met the need perfectly. The magnified pinhead-size assembly shown above has a half-round sapphire jewel. The pin limits balance motion.

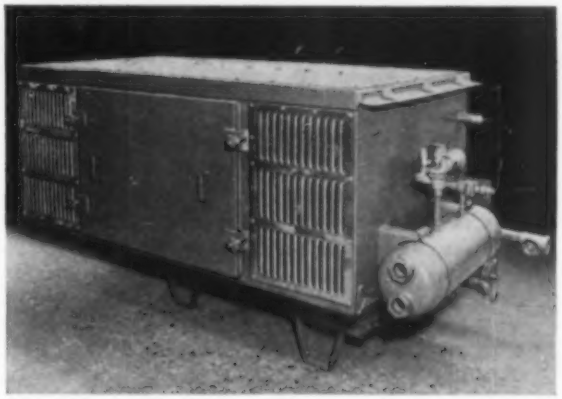


ALLIS-CHALMERS – building what may be the world's largest surface condenser for Commonwealth Edison Co. – needed tube sheets which combined strength and corrosion resistance with machinability. The answer was Anaconda leaded Muntz metal – 4 plates, each 13' x 17', 1⅛" thick, weighing over 7 tons. When drilled, plates support 21,960 tubes, for 200,000 square feet of condensing area.



SQUARE D COMPANY needed low electrical resistance, high spring properties, fatigue resistance in critical parts (in color above) of their QO circuit breaker. Electrical resistance of ordinary phosphor bronzes was too high. So was the cost. Engineers of The American Brass Company suggested Anaconda Ambronze-474 and Square D found it had the right combination of properties for the need. And this metal provided superior forming and lower material costs.

Starting with 93 standard alloys, The American Brass Company can make minor variations in composition, fabrication, and annealing to provide an almost unlimited number of combinations of useful properties. When new or unusual problems rise, ask for the help of the Technical Dept. in selecting the right metal. For such help or a copy of Publication B-32, "Anaconda Copper & Copper Alloys," write: The American Brass Company, Waterbury 20, Conn. 5854



THE TRANE COMPANY'S railroad air-conditioning "dry-wet" combination condensers are mounted under cars – facing severe corrosive conditions and a beating from roadbed gravel and stone. Exposed metal, including casing, liquid receiver, 170-gal. water tank, must have superior corrosion resistance, high strength and toughness. Trane has found Everdur®, Anaconda's group of copper silicon alloys, meets its needs. And Everdur is easy to fabricate.

ANACONDA®

COPPER · BRASS · BRONZE · NICKEL SILVER MILL PRODUCTS

Made by The American Brass Company

Weldability—Welding is the only technique that we can use to join two pieces of metal so that they act as a single piece of metal.

Not *all* metals. Steel stands alone as the most weldable of all practical metals. Not *all* steels, but most of them can be welded without any sacrifice of strength or elastic behavior. More than that, steel can usually be welded without special precautions, without critical timing procedures, without excessive heat input, without elaborate and corrosive fluxes, without color change in the base metal, and with little danger of cracking. Welding engineers deserve most of the credit for the fact that steel can be welded so easily. With their help, steel producers have made many important break-throughs.

Before the 1930's, carbon and manganese were the main strength-producing elements in steel. Designers wanted stronger steels so they could build lighter structures—and they wanted to *weld* these steels because there is no lighter fastening system. But as the carbon content was raised to strengthen the steels, the weldability decreased and designers were handicapped because they had to fasten "light-weight" high carbon steels with heavy rivet and gusset-plate assemblies.

In 1933 United States Steel introduced the first *low carbon*, high-strength, low-alloy steel—USS COR-TEN Steel—and later USS TRI-TEN Steel. Both steels achieved 50,000 psi minimum yield strength with alloying elements other than carbon, and could be welded with normal procedures. The world of alloy steels was brightened, too, with the introduction a few years ago of USS "T-1" Steel, a constructional alloy steel combining tremendous strength (100,000 psi min. yield strength), toughness *and* weldability without requiring preheating or stress relief.

No matter what combination of properties you desire in a steel, there is a weldable steel that will do the job. In fact, there is theoretically *one* best steel for any application, and it can be selected from our family of Steels for Design: Carbon, High Strength, Alloy and Stainless. If you could use help in finding it, check United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

United States Steel Corporation • American Steel & Wire • Columbia-Geneva Steel • National Tube
Tennessee Coal & Iron • United States Steel Supply • United States Steel Export Company

USS United States Steel

STEELS FOR DESIGN

Lower Left—Problem: Design butt-weld fittings for high-pressure oil and gas lines. Solution: Designer used USS TRI-TEN Steel, a high-strength, low-alloy steel particularly noted for its weldability. Pay-off: Fittings made lighter due to thinner plates; welding was fast and easy; less weld metal was needed; and the weld was as strong as the parent metal.

Lower Middle—Problem: Build a bedplate for a printing press requiring 534 welds. Solution: Builder used USS "T-1" Constructional Alloy Steel. Pay-off: Tremendous strength and toughness of "T-1" withstands thunderous impact from high-speed printing rollers and cutting knives—*and not one weld has failed.*

Lower Right—Problem: Convert a concrete reservoir into a storage area for 2,000,000 gallons of ammonium nitrate. Solution: Reservoir was lined with corrosion-resistant USS Stainless Steel sheets. Pay-off: Quick, easy installation because the Stainless sheets were welded right on the job—3½ *miles* of lap seams were welded and only two tiny imperfections were found when the welds were vacuum tested.

USS, "T-1," Cor-Ten and Tri-Ten are registered trademarks

When you buy Motor Starters--

YOU PAY FOR OVERLOAD PROTECTION

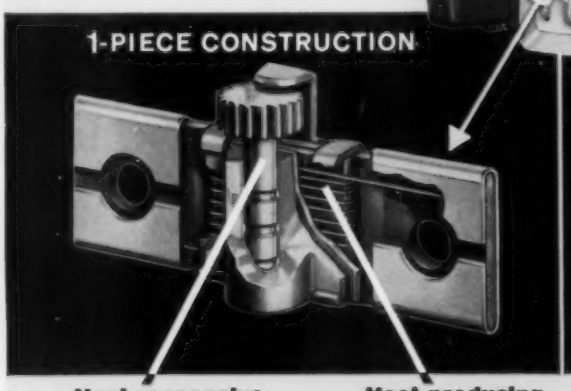
Only ONE-PIECE Overload Relays give 100% Protection • Only with ONE-PIECE construction can you *know* you've installed the heater correctly. Only with ONE-PIECE construction can you *know* the heater is exactly centered, or properly positioned, so that it performs according to its rating. Only with ONE-PIECE construction can you *know* your motors have full protection.

Only Square D has ONE-PIECE Construction • ONE-PIECE construction *eliminates* any possibility of heater misalignment. Square D melting alloy thermal overload relays can be installed only one way. They are tamper-proof. They are factory-assembled, are *individually* calibrated and tested. Repeated tripping will not affect accuracy.

Insist on Square D melting alloy thermal overload relays

***Write** for Bulletin SM-275 for the complete story on Square D starters with ONE-PIECE thermal overload relays. Address Square D Company, 4041 N. Richards St., Milwaukee 12, Wisconsin.*

...BE SURE YOU GET IT!



Heat-responsive element (solder pot) provides accurate response to overload, yet prevents nuisance tripping.

Heat-producing element is an integral part of overload unit. It's permanently joined to solder pot, can't become misaligned.

Individual factory inspection of every Square D melting alloy thermal overload relay means performance you can trust. Each unit is calibrated and thoroughly tested to make sure it will perform according to its rating.

EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE

SQUARE D COMPANY

How USS Shelby Seamless Tubing improves the design of this portable drilling rig

This is the FAILING 1500 HOLEMASTER®, an all-purpose drilling unit built by the George E. Failing Co. of Enid, Oklahoma. Truck-mounted, the rig will handle drill pipe and casing loads up to 25,000 lbs. It is rated to drill to 1,500 feet with 2⅜-inch drill pipe.

Shelby* Seamless alloy steel tubing was used extensively in the 42-foot mast. It was chosen as the design material because it offers the ultimate in strength and rigidity in proportion to its size and weight. It is uniform throughout, dimensionally accurate, and possesses superior welding and machining properties. Furthermore, the symmetrical tubing improves the general appearance of the rig. For the four vertical legs, which bear the brunt of the weight, Shelby Seamless was used as follows:

162 ft. of 2⅜" OD x 5/32" wall
18 ft. of 1⅝" OD x 11 ga. wall
66 ft. of 1⅜" OD x 11 ga. wall
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USS* Shelby Seamless Mechanical Tubing is available in a wide range of diameters, wall thicknesses, various shapes and steel analyses. For further information or immediate delivery of Shelby Tubing, call your Shelby Seamless Tubing Distributor. Or, write to National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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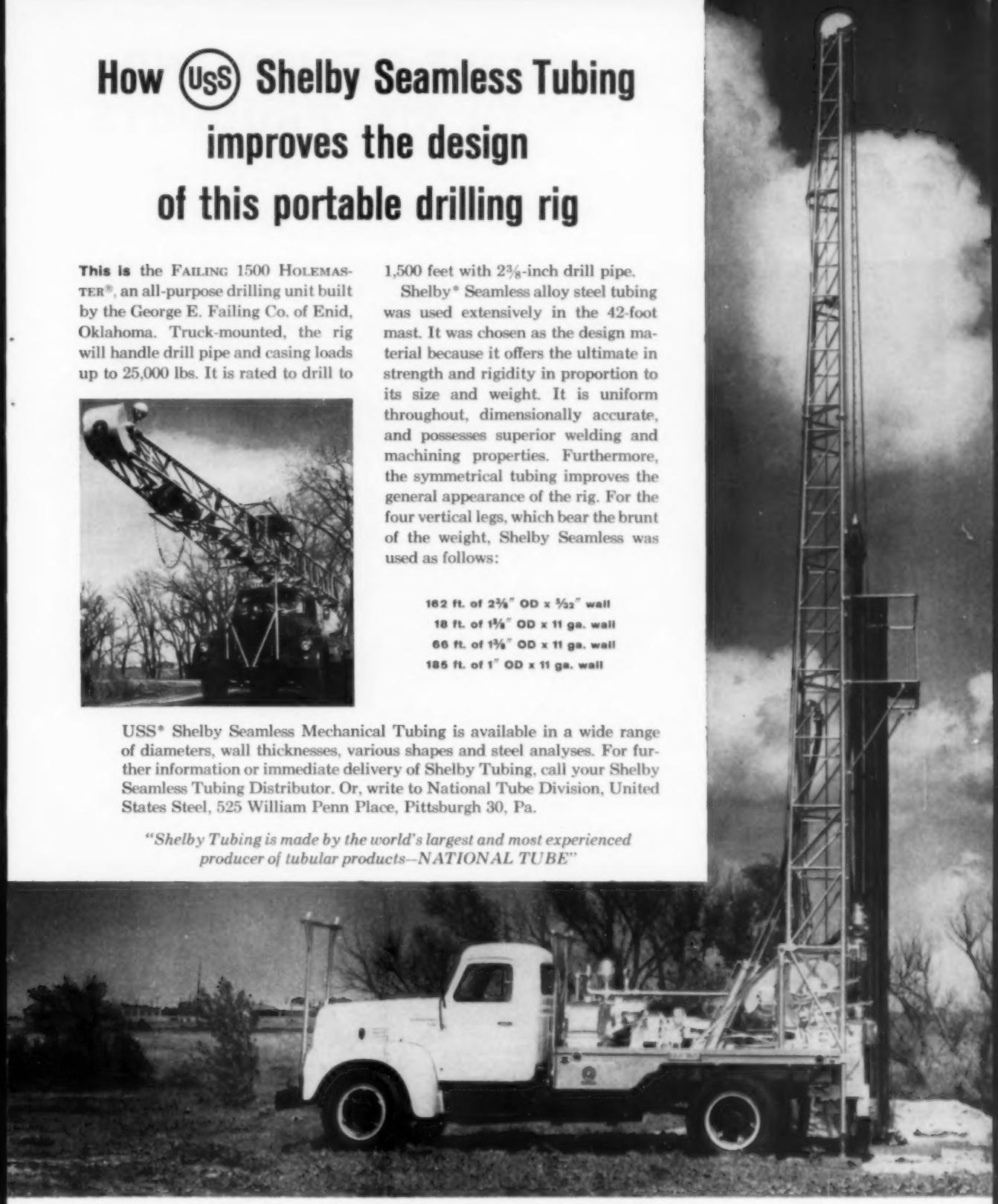

National Tube Division of USS United States Steel

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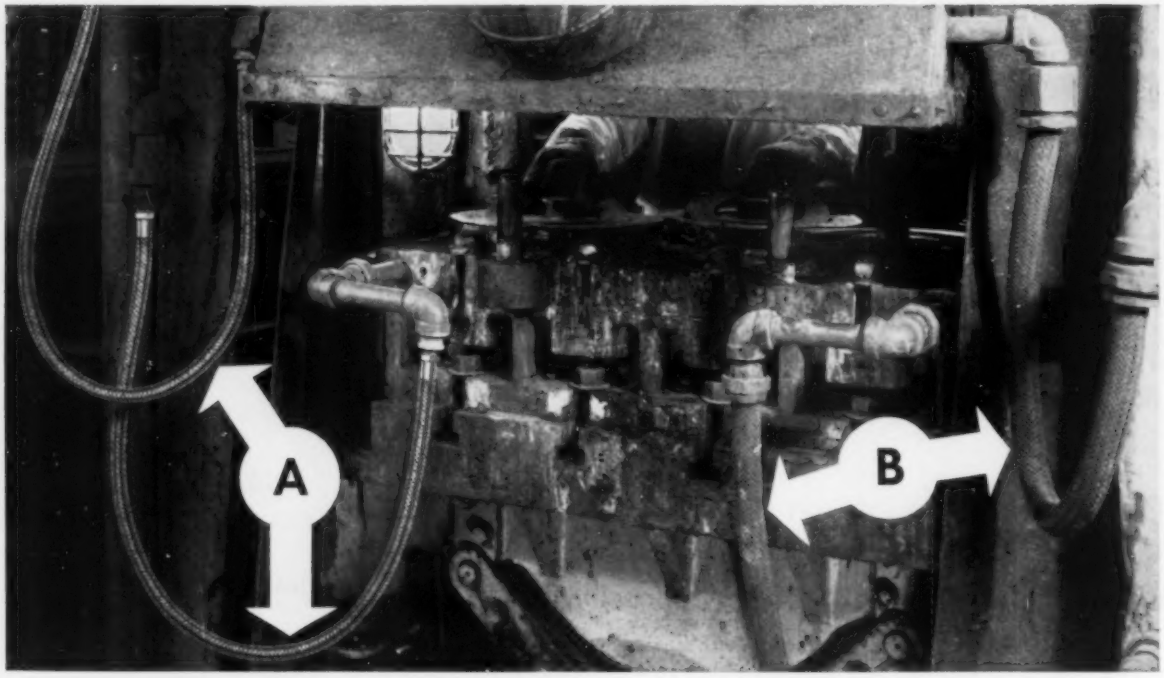

Steam lines to hydraulic press. (A) Wire-braided R/M "Teflon" hose—no failure due to corrosion or normal wear since installation in 1955. (B) Old-type wire-braid reinforced corrugated metal hose—has had to be replaced every 4 months.

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Here's a graphic illustration of the superiority of R/M "Teflon" over ordinary materials. The larger diameter of the clumsy metal hose is to compensate for the space needed for the corrugated hose wall and its relatively rough inside surface. Consider the big savings in labor and materials costs resulting from the use of R/M "Teflon" hose!

Raybestos-Manhattan has had years of experience in working with "Teflon"... in making the most of its unique characteristics. Our technicians and the laboratories they work in have an outstanding record of achievement in the development and testing of products made from this versatile material. R/M's production facilities are unsurpassed. Together, they tackle the "it-can't-be-done" assignments in stride.

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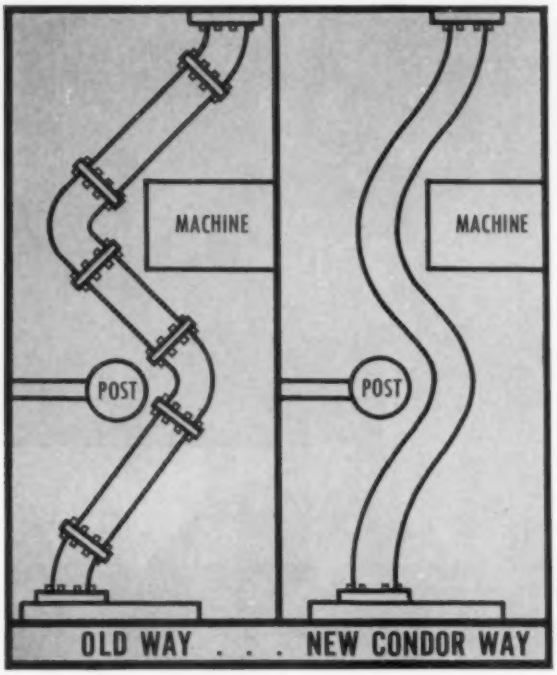

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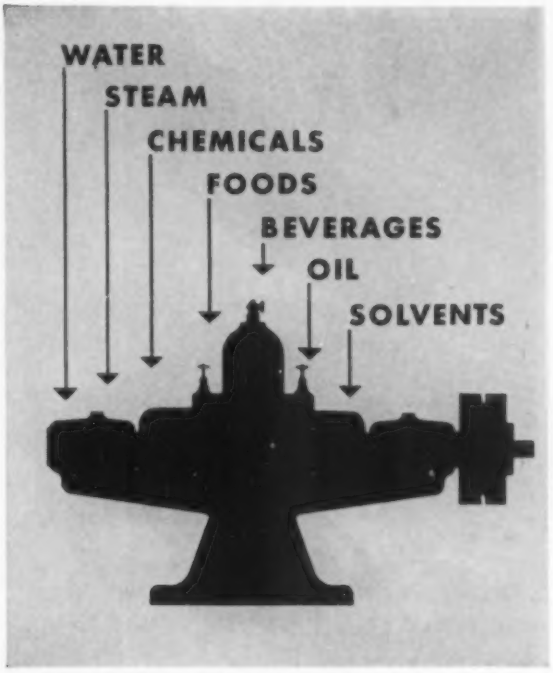
Where corrosion, abrasion, vibration or contamination means trouble with iron or steel pipe, versatile Condor Flexible Rubber Pipe is your solution. It actually outlasts other conventional piping in handling coal or coke breeze, ashes, finely broken up materials and many slurries, corrosive liquids and caustic solutions. Whatever the application, Condor Flexible Rubber Pipe goes where you want it to go . . . eliminating fabricated, leaky joints and cumbersome supports. Raybestos-Manhattan also makes to your special order rubber expansion joints, rubber-lined pipe, fittings and process equipment, acid hose, rubber covered rolls. You can depend on R/M also for rubber hose, transmission belt and V-belts, Poly-V drives, conveyor belt, molded and extruded rubber products. Rubber specialists since 1893.



Two R/M Plastic Packings—R/M Universal and R/M "versi-pak"®—answer the designer's problem of lower friction and longer wear

These superlative R/M packings have features that will pay off in every pump and valve you design. Both are custom made for low friction and for maximum resistance to heat, materials handled, and pressure. Locked-in lubrication and soft, open-fiber asbestos combine to reduce wear on rods and valve stems, even after long service.

In Universal Plastic Packing, R/M has combined asbestos fiber and graphite with lubricant and binder. Designed for all types of circulating, reciprocating and centrifugal pumps. Types are also available for oil and for food processing equipment. R/M "versi-pak" is similar in composition, but has a special solvent-proof binder that makes it ideal for solvent installations up to 350 F and 600 psi. Send for complete data for specific recommendations.

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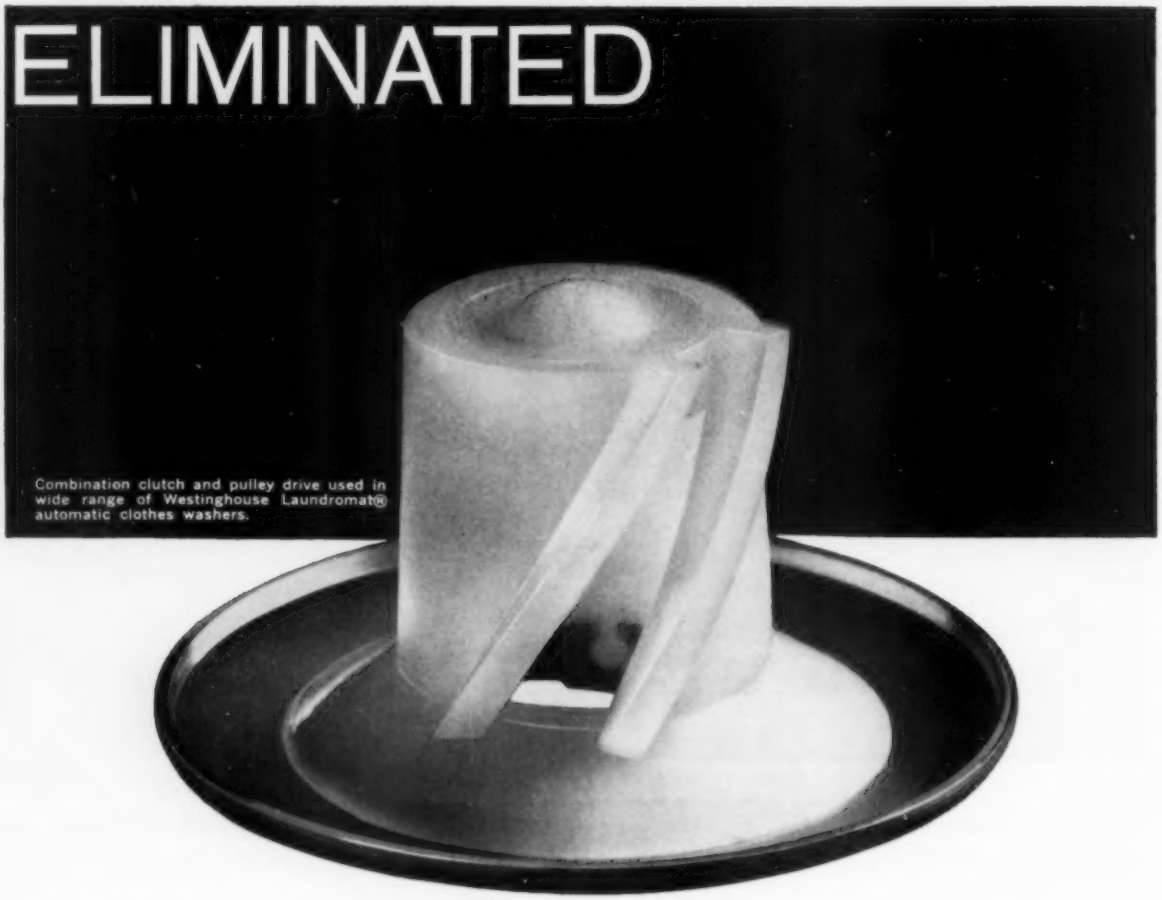

Combination clutch and pulley drive used in wide range of Westinghouse Laundromat® automatic clothes washers.

WHEN CHICAGO MOLDED SHOWS HOW NYLON CAN REPLACE METAL . . . AND MAKE A BETTER PART, FOR LESS

By coming up with an imaginative approach, Chicago Molded engineers eliminated a costly machining operation previously needed on this pulley slide when it was made of metal. The solution: a nylon body with a stamped metal insert (sheet steel, flash plated with copper).

This was no mean designing feat. Chicago Molded engineers not only had to produce a less expensive part, but recommend materials and methods that would come up to commercial standards in mass production. This included meeting close tolerances on both the internal diameter of the shaft and the slot – not easy to mold on a multiple contour shape. Another complicating factor was injection-molding around a metal insert.

Working with the Westinghouse Laundromat engineering group, Chicago Molded also came up with a versatile, flash-free mold that could be used to make two different pulley slides. This is necessary because there are *two* slide types, each with a different helical pitch (24° right and 14° left). What they did was design a multiple cavity mold that permits simultaneous production of *both types*. The secret: removable sections in the mold for changing the pitch.

The success of this design illustrates the *cost-cutting* results you get by having Chicago Molded engineers work with your people in the blueprint stages. In suggesting materials and modifications – as well as in designing molds – they can, as they did for Westinghouse, make a better product at lower cost. Perhaps that's why 66% of Chicago Molded's business comes from firms served for over 25 years.

Write today for a free subscription to Plastics Progress, Chicago Molded's data-packed magazine on up-to-date developments in plastics.

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Steel lined with bronze, babbitt, copper or aluminum alloy
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Many lengths and diameters

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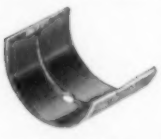
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Mining and Drilling Equipment, Crawler Crane and Hoist Manufacturers specify . . .

HEIM *Unibal*®
SPHERICAL BEARING
ROD ENDS

There are heavy duty Heim Unibal Rod End Bearings with BIG capacity and durability for use on unusually heavy linkages. They operate the compressed air clutch; they control the swing mechanism and the steering brakes; they help eliminate slack in the reverse swing and travel clutches; and contribute to the dependability and low maintenance of such heavy duty equipment.

The shapes and sizes, methods of fabrication and types of attachment to adjacent units are as varied as the number of installations. Heim Unibal is easy to install, easy to inspect, and easy to maintain.

No other device can correct misalignment better than Unibal, the spherical bearing. The maximum angle of misalignment for each of three types of mountings most commonly in use, is shown in this drawing . . .

For rod end applications in linkage mechanisms, other limiting factors may prevail, but the ability of the Unibal Rod End bearing to correct misalignment varies only in degree.

A wide range of stock sizes is available.

HEIM UNIBAL SPHERICAL BEARING ROD ENDS

Rod End	B	D	G	Maximum Static Radial Load
F Series	.1901 – 5000	.750 – 1.312	1.750 – 3.031	2,848 – 7,202 lbs.
M Series	.1900 – 2500	.750 – .938	1.935 – 2.969	1,695 – 3,723 lbs.
MF Series	.1250 – 7500	.469 – 1.750	1.046 – 3.750	1,201 – 11,326 lbs.
HM Series	.1250 – 7500	.469 – 1.750	1.172 – 3.750	452 – 11,326 lbs.
HFX Series	.2500 – 7500	.750 – 1.750	1.687 – 3.750	5,390 – 23,234 lbs.
HMX Series	.2500 – 7500	.750 – 1.750	1.937 – 3.750	5,390 – 23,234 lbs.

Components for Unibal Rod Ends are made of various suitable materials. Lubricators are supplied when specified. The Heim catalog gives complete specifications on all stock items; be sure to have one at your finger tips.

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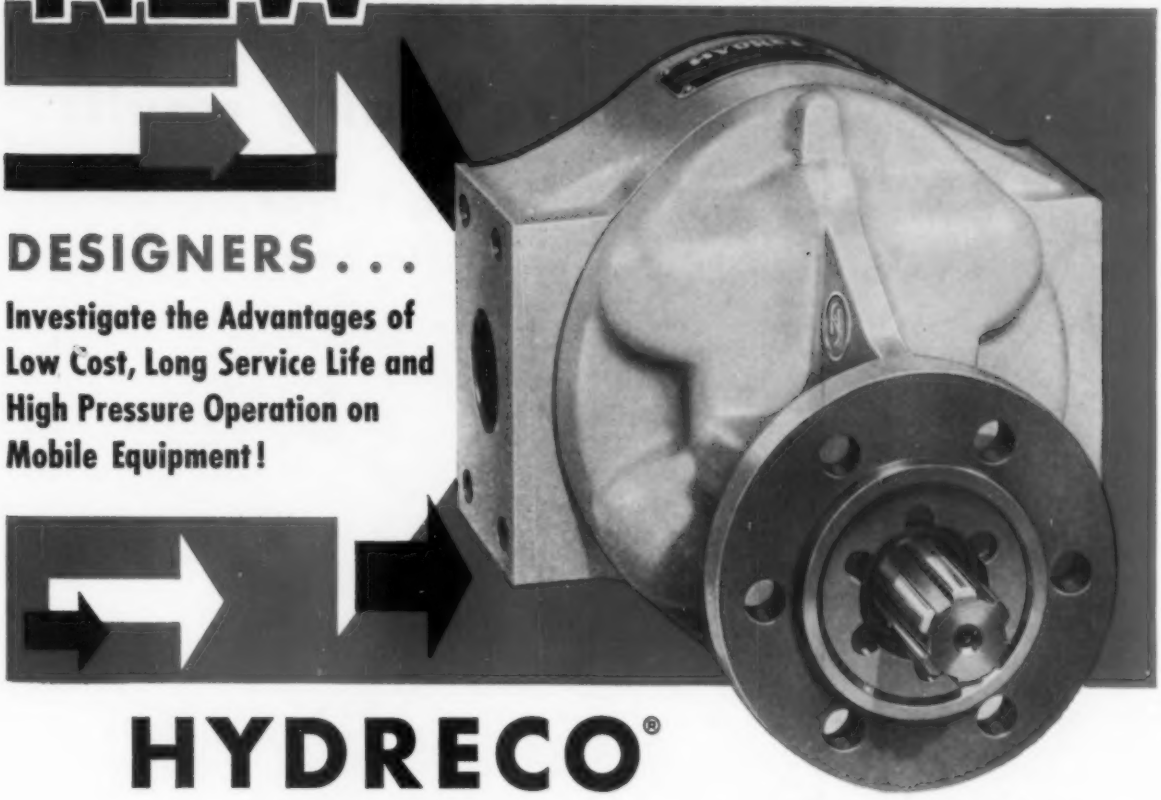

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Operating Pressures to 2000 psi
40 gpm at 1800 rpm
Operating pressures to 1500 psi

Designed to cover a broad range of difficult applications, such as: heavy duty earth moving, road building and materials handling equipment. They feature four design advances that add up to . . . *More Duty Hours at Top Volumetric Efficiency and Minimum Cost.*

- Piloted housing and end covers eliminate shifting.
- Thrust bearing – to take axial thrust of hydraulic forces.
- Two-stage seal – runs cooler – lasts longer.
- Improved shaft bearings – tolerate increased loading.

The 2100 Series of HYDRECO Gear Pumps embraces heavy duty applications in the range immediately below that covered by the famous HYDRECO 3000K Series. Thus, with the 2100 and 3000K Series engineers have a broad selection of sizes in Hydraulic Pumps with established history of high performance and dependability.

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to give quality results

with Extras . . . at No Extra Cost!

You get more—much more—when you specify and use any of T-J's complete line of Spacemaker cylinders. The Spacemaker is engineered to give you better, more accurate, and longer service—offers, exclusively, many extras . . . that are STANDARD, AT NO EXTRA COST!

Designed to eliminate tie-rods, providing greater strength . . . saves space . . . reduces manhours and costs in all push-pull-lift operations. IMMEDIATE SHIPMENT in a wide range of styles and capacities, with 64,000 combinations. Write for Bulletin SM 155-3 with complete engineering details. The Tomkins-Johnson Co., Jackson, Mich.

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FORGED SOLID STEEL HEADS . . . Standard at No Extra Cost!

PERSPECTIVES

in design and development . . .

Down to the Sea

The big question confronting the Congressional Underseas Warfare Advisory Panel is: In a future war will the oceans be our enemies or allies? Formerly they were considered allies. But two modernisms—nuclear power and the ballistic missile—have now joined forces with the submarine and the combined result is a most effective weapon. It is a specially designed nuclear-powered submarine carrying about 15 or 16 Polaris intermediate-range ballistic missiles. At first such a combination was regarded as a stop-gap to make up for the delay in getting an ICBM operational. But continued analysis shows the Polaris weapon system has the following advantages of its own: It would be relatively immune to surprise attack because it can remain submerged anywhere; it would greatly complicate the defensive problems of the enemy; its base would be the wide ocean rather than a populated land installation where it would draw counterfire; it promises the US an alternative to land-basing its missile-launching stations in densely populated ally nations.

The Problems

But the advisory panel, which reports to the Subcommittee on Military Applications of the Joint Committee on Atomic Energy, also feels that we can't by any means count on monopolizing the idea. It foresees the Soviets able to mount such an IRBM attack from the sea in the early 1960s. What, then, would be our defense? The panel says we have no weapon, even on an experimental basis, that would be adequate against nuclear subs. Here's how the panel develops its thesis:

It doubts whether our current research and development program will provide effective defense in time to meet the threat . . . the need for defense against Polaris-type subs may soon match the problem of air defense but financial support of R & D for anti-sub warfare has been inadequate in comparison with the support given air defense and missile development programs . . . too little R & D effort in the Navy is aimed at major improvements in weapon systems . . . basic scientific research in fields of great concern to undersea warfare (oceonography is an important example) also has been inadequately supported and is urgently needed . . . and finally, the panel claims that the US has moved too slowly in developing nuclear weapons for anti-submarine warfare.

Now considered the major obstacle to widespread use of submarines for anti-sub warfare (as well as for launching missiles) is the problem of radio communication. This involves getting across the air-water barrier, as well as a sub's communicating with its fellow ships undersea.

Actually the Navy does have one big punch in the making: an underwater-launched missile called Subroc. Considered by some a more sophisticated weapon-systems idea than the Polaris, it's designed to detect an enemy sub at long range, compute its course and speed, and fire the missile to destroy it. Such a missile would be fired out of the torpedo tubes underwater and rise out of the water. Then, powered by a solid-fueled rocket it would fly to the vicinity of the enemy submarine, reenter the water and home in on the target. With a missile range of up to 2,000 miles, the weapon is being considered for shore targets. Goodyear Aircraft Co is developing the system. Another Navy project is a noise reducer for nuclear subs, which are nosier than conventional subs. One method: direct conversion of heat to electricity through thermocouples, eliminating turbins and generators.—PAUL ANDERSON

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First, the saving in material on the General Electric Dishwasher . . . a Tinnerman SPEED NUT brand fastener is formed right in a channel stamped from high-carbon spring steel. This replaces a costly solid steel bar formerly used to mount the pull-out basket rollers.

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A call to your Tinnerman Sales Representative will be the start. He's in the Yellow Pages under "Fasteners".

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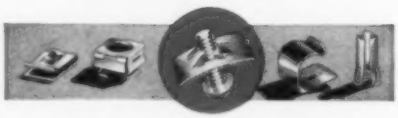

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PLAN '59

HOW MODERN IS AMERICAN INDUSTRY?

A REPORT BY THE McGRAW-HILL DEPARTMENT OF ECONOMICS

THE U.S.A. is starting a new period of economic growth, as we leave behind the recession of 1958. This new period presents a challenge to the nation, to the business community and above all to the individual company – to grow *at a profit*.

By now it is clear that growth is the normal way of life for the U.S. Economy. Since 1947, our national product has been growing at a rate of 3.7% a year. And no recession, even the latest and most publicized, has interrupted the trend for long. Now the economy is growing again.

But the conditions of growth are far different from those that prevailed in the years 1947 to 1957.

Today growth in the economy does not mean pressure on capacity, for most industrial firms. It does not mean easy profits. Rather, this is growth under highly competitive conditions, with profits dependent on a firm's ability to hold down costs. **Is our plant and equipment modern enough to do the job?**

A New Survey

To find the answers to this question, the McGraw-Hill Department of Economics has just completed a special survey of business needs for modernization. **The survey shows that it would cost $95 billion to replace today's obsolete equipment.** And this is a priority job, if business is to get costs down for the years ahead.

This tremendous need for modernization presents a challenge to the U.S.A. as a nation. The Communist powers are making a strong and disciplined effort to demonstrate that they can out-produce us – that they can "plow us under" in a contest of industrial strength.

It is a challenge to American business. Our people expect a continuously rising standard of living. Our workers expect wage increases. And often their demands mean price inflation – unless we can achieve sharp gains in output. The public demands higher national income without inflation. This is the challenge to business as a whole.

It is a challenge to the individual firm. Growth in the economy no longer means an automatic rise in sales and profits for any particular company. There are no shortages; industrial capacity is ample. So to participate in growth, the individual firm must achieve better quality or lower costs than its competitors. Otherwise, there will be no profit in growth and no success story for the company.

Is business prepared today for these challenges? The answer, from our study, is clearly "No". The production and distribution facilities of the U.S.A. are not efficient enough to ensure our continuing superiority over the Communist world, to match every wage increase with higher productivity, to do business in a competitive economy at satisfactory profit to the individual firm.

This statement sounds shocking at a time when much industrial capacity is idle and the recession just behind us is being blamed on a surplus of capital goods. But the facts speak for themselves. Here is the record on the past decade of investment in new plant and equipment, and here is our new study of the job that still remains to be done.

THE MODERNIZATION JOB AHEAD: $95 BILLION

The McGraw-Hill Department of Economics asked a wide sample of manufacturing companies, and experts in other industries, "What would be the cost to replace all obsolete facilities with the best new plant and equipment?" Here is a summary of the estimates. (Details on next page.)

MANUFACTURING AND MINING	$34.3 Billion
PETROLEUM INDUSTRY	5.3
TRANSPORTATION AND COMMUNICATIONS	18.4
ELECTRIC AND GAS UTILITIES	12.0
FINANCE, TRADE AND SERVICES	25.0
TOTAL: ALL BUSINESS	$95.0 Billion

Decade of Expansion[1]

Since 1947, private business in the U.S.A. has invested $291 billion in new plant and equipment. Our manufacturing capacity has increased about 80%; electric power capacity, 145%; capacity for basic raw mate-

[1] Figures on "Decade of Expansion" are for the years 1947-1957 inclusive, except where specific reference is made to preliminary data for 1958.

THE McGRAW-HILL SURVEY OF MODERNIZATION NEEDS

Conducted by the McGraw-Hill Department of Economics in August, 1958

INDUSTRY:	AGE OF MANUFACTURING CAPACITY Percent Installed: Prior to Dec. 1945	Dec. 1945 to Dec. 1950	Dec. 1950 to Dec. 1957	COST TO REPLACE OBSOLETE FACILITIES: Millions of $
Iron and Steel	47%	16%	37%	2,855
Nonferrous Metals	47	13	40	1,022
Machinery	41	21	38	3,224
Electrical Machinery	34	18	48	1,917
Autos, Trucks and Parts	42	11	47	2,204
Transportation Equipment (aircraft, ships, railroad equipment)	59	9	32	854
Other Metalworking	54	17	29	2,351
Chemicals	30	23	47	3,070
Paper and Pulp	49	17	34	2,655
Rubber	46	9	45	600
Stone, Clay and Glass	46	20	34	1,840
Petroleum Refining	45	26	29	1,499
Food and Beverages	58	19	23	3,443
Textiles	59	18	23	1,001
Misc. Manufacturing	51	21	28	6,236
ALL MANUFACTURING[1]	48	19	33	34,771

[1] Includes petroleum refinery companies listed under "petroleum industry" in previous table.

rials, by 55%. The distribution and service industries have increased floor space by roughly 50% in the decade. In 1957 alone, business spent $37 billion on new plants and equipment – more than the combined expenditure in all of Western Europe plus Canada.

But all of this expenditure has not made our facilities as modern as supposed, or as modern as we need. Of the $291 billion invested by business since 1947, roughly $157 billion has been for expansion of capacity. Only $134 billion has been spent to replace old facilities with better, more modern equipment. And in recent years, this investment has not purchased as much new equipment as the dollar figures suggest, because prices of capital goods have climbed.

Our postwar capital investment has repaired the worst of the obsolescence accumulated during the depression and war years. But huge amounts of old equipment are still in use, as shown by the table above. This is based on a survey of the age of manufacturing capacity in several hundred companies, representing all of the major manufacturing industries. Almost 50% of our present capacity was installed before or during World War II. More than 65% was installed before Korea. Expert studies of the major non-manufacturing industries show that the age of equipment, in those industries, is even greater.

Thus, of all business plant and equipment, less than one-third is modern in the sense of "new" since 1950; two-thirds is pre-Korea.

This over-all figure is confirmed by a check on specific industries:

- Nearly two-thirds of our metalworking equipment was installed over 10 years ago, according to preliminary results of AMERICAN MACHINIST'S 1958 census.
- Over 65% of the freight cars on our railroads are more than 10 years old.
- Less than half the capacity to process chemicals, rubber or petroleum is new since 1950 – a period that has seen rapid development in such equipment as automatic controls for these process industries.

These examples take on a dollars-and-cents meaning when we recognize that the latest machine tools are about 40% more productive than 1948 models, and that a combination of new freight cars and modern freight yard equipment can reduce operating costs up to 50%. New instruments, that automatically direct the flow of a chemical (or other raw material) process, can often reduce processing costs enough to pay back the cost of the instruments in one year. These savings cannot be made in older plants. By using obsolete facilities, our industries accept a waste in labor and materials that totals many billions of dollars per year.

Why Productivity Must Rise

The U.S.A. can ill afford this waste. In the economic struggle between the free world and Communist world, our margin of superiority depends on the efficiency of our productive facilities.

For the growth of our own economy, we shall need a sharp rise in productive efficiency. During the next ten years, American business must provide the goods and services required for a population that will increase by 32 million. And the increased population will expect higher living standards. Furthermore, the population in ten years will include a higher proportion of dependent persons – children and retired people – and a smaller proportion of working age men. Thus, with a relatively smaller labor force, industry must provide more goods for more consumers.

At the same time, industry must strive to hold the line against rising costs. In an economy with a tight

labor supply, we cannot count on restraint in wage demands, however desirable such a development might be. In the past ten years, hourly wage rates have increased over 5% per year, nearly twice as fast as output per manhour. And this disparity may well continue – causing still more inflation–unless we make more rapid gains in productivity.

We can make these rapid gains – if industry goes all out to modernize its equipment. Output per manhour (in manufacturing) has increased only 2.5% per year since 1951. But this compares with gains of 4% a year in 1947-1950, and over 5% in the 1920s. Today the machines and techniques are available for us to equal, or exceed, these records – to raise output per manhour at least 5% per year. This is a job that can, and indeed must be done, to assure growth in the economy without inflation.

The Job Ahead

The dimensions of this opportunity are shown by the table on the previous page. In its survey on the need for modernization, the McGraw-Hill Department of Economics asked a wide sample of manufacturing companies how much it would cost to replace *all* their out-dated facilities with the best new equipment available. The Department also interviewed experts in each of the nonmanufacturing industries, to find answers to this question. The answers add up to a staggering bill for new plant and equipment.

Modernization of over-age facilities – replacing only what is really obsolete, by today's production standards – would require a total capital investment of $95 billion, or nearly $20 billion per year for the next 5 years.

Furthermore, new production techniques will soon make *today's* plants obsolete, in many cases. Thus, to keep pace with technical advance *from 1958 on*, will require continuing expenditures of $8 to $10 billion per year for modernization.[1]

The total expenditure to wipe out the backlog of obsolete facilities, and keep up with continuing technical advance between now and 1963, would be at least $135 billion.

The U.S.A. has never spent such a sum on the modernization of industrial facilities. Capital expenditures of boom dimension have, in the past, been associated only with the urgent expansion of capacity. **Some forecasters are now saying that because industrial capacity is adequate, the next few years will be a period of low capital investment. The figures above make clear that this would be a national calamity.** The opportunity is there–and the challenge–to invest record amounts of capital in the modernization of plant and equipment.

A National Problem

This also is a challenge to the U.S.A. as a nation. For 100 years, this nation has been looked to as the model of economic development by the rest of the world. For the first time, we face a serious challenge by another nation and another economic system that claims to be better. In a carefully documented 111 page study released in May, the U.S. State Department declared that "the most serious threat" to the U.S.A. today is the drive for economic supremacy by the Soviet Union.[2] Although a much smaller nation industrially than the U.S.A., the U.S.S.R. is today increasing its national output at a rate of 7% per year and its output per manhour by 4% per year.

The U.S.A. does not have to match these specific figures, which represent the results of forced labor in a country just starting to develop industrially. In the contest to win uncommitted nations, the statistics are not likely to be quoted exactly, in any case. But our over-all growth in national output and living standards must be so impressive as to leave no question of superiority. Our factories must be showplaces of modernization to the foreign visitor that will leave him unable to say "I saw much better" in Britain, or West Germany, or Russia.

This is the challenge to the nation –a political challenge to be sure. But it coincides with the challenge to the business community and the individual firm. And the way to meet it is the same: by thorough and rapid modernization of our plant and equipment – not by the slow and steady pace of recent years, but at an accelerated rate that reflects the greater pressure for output at lower cost.

Obstacles To Be Overcome

We must face up to the fact that real obstacles – both technical and financial–stand in the way of faster modernization. Some companies do not have the technical "know-how" required for the latest production techniques. Many more lack the financial resources. How can we overcome such obstacles, and speed up the replacement of old facilities?

In the course of its study, the Department of Economics obtained comments on these questions from many executives. One of the problems, as we noted above, has been the urgent pressure to expand capacity during most of the postwar period. In giving their attention to this problem, companies have sometimes overlooked the chance to modernize older plants.

In some cases, equipment has been kept in place because it was satisfactory, and the users were not aware of still newer designs. Some equipment users believe that equipment makers are not sufficiently aggressive in designing and demonstrating new models.

The biggest obstacle – and one that presents a persistent problem – is the shortage of funds in many companies that need and want to modernize. For all corporations, the cash flow from retained earnings and depreciation has increased by more than $5 billion from 1953 to 1958. But a number of key indus-

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[1] This estimate is based on technical developments reported by McGraw-Hill editors and current price trends for capital goods. It is consistent with the plans for modernization expenditures in 1958-61 reported by companies in a McGraw-Hill survey conducted in April, 1958.

[2] "The Sino-Soviet Economic Offensive in the Less Developed Countries" – U.S. Department of State, May, 1958.

MODERNIZATION PAYS

Profits on modernization—like all business profits—have come down since 1955. However, modernization, in contrast to new capacity, still offers a relatively quick return on investment. Here are companies' answers to the question: "In cases where you are actually replacing old facilities with new plant and equipment in 1958—how soon do you expect these replacement expenditures to pay off?"

	PERCENT OF COMPANIES ANSWERING			
INDUSTRY:	1 to 2 yrs.	3 to 5 yrs.	6 to 8 yrs.	9 yrs. and over
Iron and Steel	11%	56%	11%	22%
Nonferrous Metals	29	71	0	0
Machinery	12	56	12	20
Electrical Machinery	29	57	7	7
Autos, Trucks and Parts	40	60	0	0
Transportation Equipment (aircraft, ships, railroad equipment)	7	53	20	20
Other Metalworking	38	33	10	19
Chemicals	10	53	21	16
Paper and Pulp	22	22	22	34
Rubber	33	33	34	0
Stone, Clay and Glass	0	57	36	7
Petroleum Refining	16	50	17	17
Food and Beverages	16	44	12	28
Textiles	37	47	5	11
Misc. Manufacturing	9	52	13	26
ALL MANUFACTURING*	18	50	14	18

**Note:* Answers to a similar question, in a 1955 McGraw-Hill survey, were as follows: 1-2 years: 17%, 3-5 years: 64%, 6-8 years: 11%, 9 years or more: 8%.

tries have failed to keep pace with the general trend. **These include some of the areas where the need for modernization is most urgent: the railroads, large sections of the textile industry, some mining industries and many small to medium-size companies in manufacturing generally.** The problem of these industries and companies has grown more acute in 1958 – since their profits have declined much more than the average for all business.

Any plan to step up the pace of modernization generally must deal with the special situation in these problem areas. Depressed industries and companies need outside help, if they are to modernize. Such help would include a stronger flow of technical information and advice (and occasionally, venture capital) from the more prosperous, inventive industries – as well as advice from equipment suppliers and distributors, industrial publishers and consultants. There is also a public responsibility to help in the problem areas—not with handouts of government money, but with technical assistance and help in finding private capital (like the efforts now being pursued by the Small Business Administration).

Certainly we should lose no time in reforming those provisions of the federal tax laws that now impede investment in modern equipment by hard-pressed firms – especially the outmoded and unfair restrictions on rates of depreciation for tax purposes. At present, the tax regulations require that depreciation be computed over relatively long periods of "useful life" for most types of equipment. And this is a primary reason for the lag in modernization. Machinery generally becomes obsolete long before the expiration of its "useful life" as specified in tax regulations. But it is difficult for companies – especially small companies – to set aside cash for rapid replacement, unless the full amount to be set aside is exempt from income tax. Canada and most European nations allow more rapid depreciation for tax purposes than does the United States.

A combination of self-help with technical help, and a fair break from the tax laws, would do much to reverse the spreading tide of obsolescence in depressed industries, and in many small companies.

PLAN '59

It is this combination that McGraw-Hill advocates as "PLAN '59", to help business modernize *now* for growth and profits. This is what it will take to make a start in 1959 on the $95 billion job of modernization, disclosed by the study we have just completed:

1. A better flow of technical information on where and how to modernize business plants and equipment.

2. Careful review by the individual company of its own opportunities to modernize at a profit – then action to replace obsolete facilities.

3. Reform of the tax laws, to allow more realistic deductions for depreciation, and permit more companies to finance adequate modernization programs from this source of funds.

Much of this program is already underway. The 34 McGraw-Hill Publications, and many suppliers and distributors of industrial equipment, have stepped up their information programs to start the modernization drive. Preliminary plans of manufacturing companies show a strong emphasis on capital spending for this purpose. In August, Congress passed a bill providing limited tax relief for small business.

But the real task of modernization still lies ahead. It is the greatest challenge, and the greatest opportunity, confronting American business as we move forward into 1959.

Product Engineering HORIZONS

October 13, 1958

PLAN '59

HOW TO MODERNIZE ENGINEERING

Last week (Oct 6 '58), we presented the first half of this two-part package—the reasons *why* you should modernize engineering equipment and methods. This week, we go on to suggest *how* the job can be done, based on visits, surveys, and previously published material.

Your particular problems and company organization dictate to some extent how your department should be set up and equipped. But are the facilities both modern and efficient, or are they susceptible to improvement? Have you had time to stand back and take a good look at them during the pre-recession rush—or since? Have you the equipment you need, the connections you should have, for special work beyond your own capacity? Are your relationships with other departments amicable—or do you get along on the basis of an armed truce?

Paper work and travel are perhaps the two most irritating problems, because both subtract from effective working time for everybody in the department with any responsibility. Yet both are essential if there is to be any creativity. The major questions are how much and when. Arbitrary limitation on either is not the answer, although some control is obviously necessary. Most effective is some sort of subdivision of this work among the men most competent at it—some men read slowly, some are ineffectual in attendance at meetings or visiting other plants. And almost all chafe under the meetings, conferences and brainstorming sessions over-zealous managers call to coordinate operations.

Needless to say, paper work should be kept to a minimum, both in required reports and permitted ones. Terseness is a valuable and acquirable characteristic. Records and reports, technical papers and articles are essential, but they can be short and to the point. Periodic sorting and checking of incoming literature is advisable to weed out the non-essential and trivial.

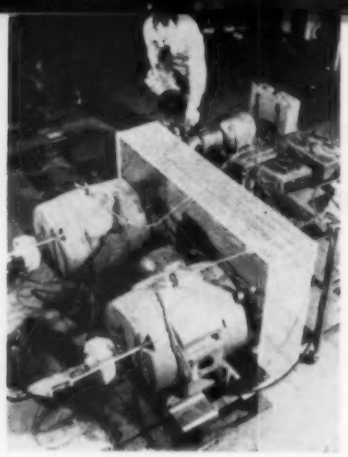
Travel should have a recognizable and demonstrable objective. It should be planned and budgeted. Results of trips should be available in report form for others, to avoid duplication of effort. Files listing names and places should be kept in systematic form, available to all.

Laboratory and model-shop equipment should not be superannuated discards, nor should drafting facilities. What about reproduction methods and equipment—have they been kept up to date? Are drawing files bulky and unmanageable—how fast can a particular drawing be found? Are drafting techniques too complicated—do drawings contain too much detail? How about computers and other modern units—or purchasable services? Is there an organized and usable library, or just a jumble of out-of-date bulletins, books and catalogs?

Such questions only you can answer. But we can provide—and have here provided—many of the checkpoints for your answers. The basic problem is to remember that modernization within is a prerequisite to product modernization, that thinking and working based on tomorrow cannot be done in an atmosphere of yesterday.

L. Stavgerman

PLAN '59



Bearing life test under thrust load at General Electric's Medium AC Motor lab at Schenectady.

WHAT YOU NEED FOR . . .

A BETTER ENGINEERING LABORATORY

Your testing setup has to keep up with the complexity of modern products. How much staff . . . what kinds of equipment . . . who gives the orders? This survey will show how your own lab stacks up against competition.

Gone is the daydreaming pace of the engineering laboratory. It has become a vital center, busy tackling design problems created by the increasing complexity of products—higher speeds . . . servo systems . . . miniaturization . . . novel structural materials.

The meaning of all this is plain. Even small differences in performance between this product and that one now loom large as selling points. And the engineering lab is where testing gives the answers—you can no longer use the customer as a proving ground.

How then to step up the lab's performance—and make it competitive? Three elements must be evaluated: How much staff, what kinds of equipment, what type of organization? Here are answers from a searching questionnaire given a representative group of chief engineers.

How Much Staff

Replies came from engineering departments ranging in size from 6 to 1200, but 33% were in the range of 20 to 100, and 46% from 100 to 250. We learned that complexity of product makes little difference; averages based on the two main groups indicate a secret of success —the larger departments employ a greater ratio of laboratory staff:

Size of engineering staff	*20 to 100*	*100 to 250*
Ratio of engineers to total employes	8.5%	11.3%
Ratio of laboratory staff to engineering staff	15.3%	20.0%

How Much Equipment

We asked each respondent to list the basic equipment it would take to set up a lab for a 50-man engineering department. We got some variety in the answers, but the composite list does show a group of basic instruments, testing devices and operating equipment essential in any lab setup. The table on next page also gives a supplementary list of other items mentioned by 50% or more.

Many replies pointed out that the type of product influences the basic list. Departments working with electrical products mentioned insulation testers, frequency standards and generators. Others listed accelerometers, Stresscote and photoelastic equipment, constant-temperature baths, and radioisotope facilities for wear testing. Several listed soundproof room and tape recorder as essential.

On the other hand, several mentioned possibility of renting a high-speed camera; replies from some smaller ones suggested using outside laboratories for tension or compression tests, and the inspection department for dimensional gages.

What Type of Organization

Who is in charge of the lab?—87% reported the engineering department alone has full responsibility. About half the reports indicate the lab is operated by someone who has this as his major responsibility; others are supervised by the chief engineer, R & D director or a staff man.

Size of staff generally is the controlling factor. The

Playback does it . . .
Tape record made on an actual road run controls 14 variables in dynamometer test of an automobile. This test stand just put into operation at Esso Research in Linden, NJ lets one operator run eight tests simultaneously. Variables include distance, acceleration, car speed, air speed, braking, tire pressure. *(For details on this driver-less testing, see PE—Aug 4, p 25)*

Controlled-atmosphere lab . . .
for testing inertial guidance instruments at Arma Corp is sterile, dust-free, and is kept at 73 F and 45 RH.

THIS IS THE EQUIPMENT . . .

for the engineering lab of a 50-man engineering department

As recommended in the *Product Engineering* survey of representative engineering departments served by an engineering laboratory.

Basic List Recommended by 95%	Supplementary List Recommended by 50% or more
INSTRUMENTS	
Dimensional gages	Vacuum tube voltmeter
Spring scale, balances	Pressure and flow gages
Microscope	Coordinate plotter
Thermometer, recorder	Multichannel oscillograph
Electrical measuring instruments	Force-displacement recorder
Potentiometer bridge	High-speed camera
Oscilloscope	
Stopwatch, chronograph	
Tachometer	
Stroboscope	
Noise meter	
Strain gage and amplifier	
TEST EQUIPMENT	
Hardness tester	Abrasion tester
Tensile, compression tester	Salt spray cabinet
Vibration table	Fungus-testing setup
Humidity chamber	
Pressure and temperature box	
OPERATING EQUIPMENT	
Air compressor	Motor-generator set
Counter, elapsed-time meter	Hydraulic pump and valves
Relays, solenoids, switches	Regulated power supply
Timers and program controllers	
Variable-speed drives	
Dynamometers	

smallest lab staff reported as working under a full-time supervisor is 9; all lab groups of 15 or more have a full-time manager responsible for scheduling projects.

Costs are charged to the job in a little over 80%, and work is done against cost estimates in about the same number (but not always in the same cases). The organizational pattern in labs staffed by 10 or more is notably the same regardless of the field, complexity of product or size of plant. The lab has a full-time supervisor responsible for scheduling, costs are estimated in advance and charged against the job.

We asked whether engineers are encouraged to handle equipment themselves; 76% say yes. Some of the remainder offer interesting qualifications such as "some," "we should," and "union regulations do not permit."

Is the lab used as a training ground for product designers? Only 45% say yes, and again there are interesting comments: "technicians only," "some," and "we ought to." Remarks by several indicated the lab is an integral part of a training plan for young engineers or technicians.

—ROBERT W CARSON,
Managing Editor

FOR TODAY'S DRAFTSMAN,

THESE MODERN TOOLS

It's time to look critically at that drafting room. Does it have the right-kind desk and board for speedy, comfortable design work? What about machines that help with drafting, equipment for reproducing the drawings, computers? Here's what to look for when modernizing.

Can design really justify sticking to drafting equipment of a type that is half a century old? Yet that's what you find in many engineering departments.

Speed and comfort—these are the keys to selecting modern tools for drafting work, which is the hub of design operations and can bottleneck the development of any product.

Why are such modern aids overlooked so often? Sometimes because designers and draftsmen fail to tell management what's new—or even, when equipment is bought in small quantities on a trial basis, fail to try it out. Sometimes because top management isn't being smart: Good design personnel are hard to find, and well worth holding onto—yet, too often, their facilities aren't nearly as spacious or well-furnished as those of other office personnel.

Here are four areas where more modern equipment or supplies can improve drafting work: (1) upright drafting boards, (2) board-desk combinations, (3) drafting machines, (4) sensitized materials. All these are fairly inexpensive in terms of the gains they make possible.

Let us also look at computers, and at the big advantage —especially to larger companies who can afford the sizeable investment—in having microfilm equipment (see top of page 70) save space in the storage of drawings.

UPRIGHT BOARDS

The modern approach is to work with the drafting board in almost vertical positions and to alternate between sitting and standing—with sitting preferable. (It's tiring to hunch over the board, sitting or standing.)

Upright boards are not a new idea. The old-fashioned pedestal-type drafting table had a board mounted on a frame which could be pivoted or raised by unscrewing certain knobs. But such awkward adjustment did not lend itself to rapid control—hence the tendency to leave the board in the same position once it was adjusted.

Most drafting tables in use today have a board as a table top which can be tilted (some for only 15°) but cannot be raised or lowered. The tables are about 37 in. high—can be raised only by slipping blocks under the legs. So even when upright, the board is awkward.

The more modern upright board is usually part of a desk but can also be purchased as an individual "table" on a metal frame (cost is about $250). Main characteristic is ease of adjustability for height position—a slight pressure, plus counterbalancing, allows the board to move up or down; a hand-release frees the board for slope adjustments through a 90° arc.

Studies at Battelle Institute's affiliate in Frankfort am Main, Germany, indicate upright boards cut drafting time of complex drawings as much as 35% (with simple drawings, the reduction was less notable). The same studies show frequent changes in drafting position are necessary to avoid aches and pains.

L-SHAPED WORKSPACES

Latest in drafting tables is a combination job—L-shaped desk and drawing board. Units can be arranged to form secluded work spaces that are the dream of every draftsman. These individual "work cubicals" were originally designed for chief draftsmen and engineers, but can be economical for the entire drafting staff.

Most drafting rooms nowdays use either a drafting table with a reference table alongside, or a front-to-back, board-desk combination—here each draftsman uses the drawing board of the table in front of him and reference desk of the table behind him. The latter arrangement takes less room and is often preferred because everything is within easy reach. Its disadvantage is conflict at times with the work of the man in the rear (or vice versa). Also, it may be less convenient to swivel the chair completely around, when referring to material, than to pile the catalogs, books, reference drawings and drafting equipment right on the board.

The L-shape units eat up less space than would be expected: all reference material can be put on the desk—therefore the boards come in smaller sizes than for the front-to-back tables. These are counterbalanced, vertical boards in sizes 30 in. x 40 in. up to 37½ in. x 50 in., that go with desks from 5 ft up to 6 ft.

The units also have telescoping legs to adjust initial height of desk and board. When horizontal, the board is flush with desk. There is a wide top drawer for prints, a tool drawer, and a special drawer for catalogs.

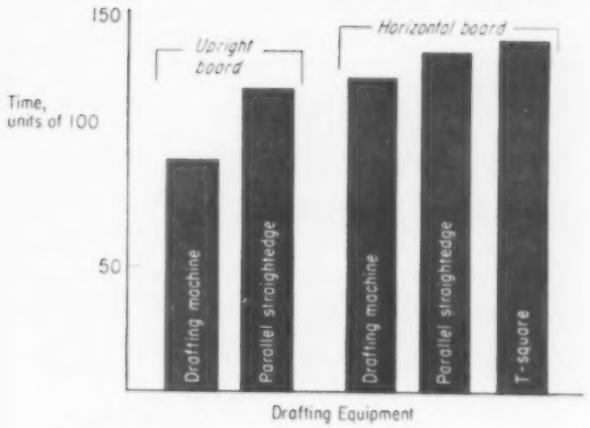
Cost-wise, an average-size L-shape table (from Hamilton Mfg Co) is about $400 as against $350 for the front-to-back table and $275 for a drafting table with a few drawers and a side reference table.

DRAFTING MACHINES

Although mechanized aids have been around for some time, many drafting rooms still use cord-guided parallel straightedges or T-squares. The Battelle Institute tests

L-shaped combination . . .
of board and desk (A) forms secluded work space. Board can be quickly adjusted for height and slope, is flush with desk (B) when horizontal.

Ball-bearing T-square
runs on side track and glides under slight pressure to any position of board.



Drafting time . . .
to make complex drawings is less with upright than with horizontal boards. Bar chart also shows higher efficiency of drafting machines.

show a marked savings in time with drafting machines—especially when combined with upright boards. With such machines there is no longer need to constantly position and reposition T-squares, triangles, scales and protractors. In fact, these tools are used only occasionally.

Drafting machines generally have an indexing head that can position the scales to any angle, with an automatic 15°-interval index stop. Vernier markings permit angular accuracies up to 5 min. The machines with two metal scales cost under $150—a price that often is repaid in less than a few months from savings in drafting time.

X-Y Tracking Machine

Latest in drafting machines are the X-Y trackers. They avoid two disadvantages:

- Tendency of a drafting machine to slide down whenever the board is tilted above 20° or so. So, when working with upright boards, a counterweighgt must be added —but besides wasting space at the rear, this can poke the man in front. Some drafting rooms insist on putting flags on the extensions.
- Scales must be kept short to get at corners, so it is impossible to draw long lines without stopping and shifting the machine.

The X-Y machines have a horizontal bar on top (some add another at the bottom) as guide for the vertical bar. An indexing head, such as found on a standard drafting machine, is attached to the vertical bar and can slide up and down, but is prevented from pivoting.

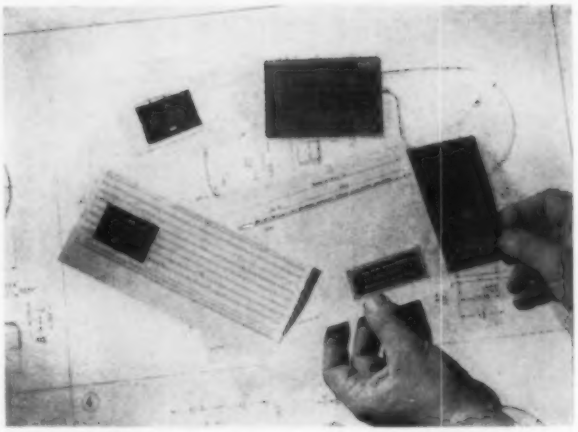
Counterbalanced belts or constant-force springs keep the machine always balanced. Drawing a long horizontal line ("tracking") is done by locking the vertical shift and sliding the drafting machine horizontally while keeping the pencil at one spot against the scale. The unit costs $30 to $50 more than a standard drafting machine.

Ball-bearing T-squares are an improvement over standard T-squares and parallel straightedges. The instruments cost only a few dollars more than straightedges (about $30) but slightest pressure on any part of their

FOR TODAY'S DRAFTSMAN,

THESE MODERN TOOLS

THE HOW AND WHY OF MICROFILMING



Miniaturized drawings . . .

take less space, are easier to handle than large, bulky tracings. Storage system can be built up around any one of three common sizes of microfilm; 35mm (shown mounted in 3 x 5 file card and in 7⅜ x 3¼ EAM card at left), 70mm (upper middle), or 105mm (in 8 x 5 envelope at right).

In itself, microfilm is not new as a security and space-saving trick. During World War II, thousands of rolls of microfilmed papers were cached away in vaults, and this form of insurance has since grown into a big business. What is new and becoming popular among large manufacturers is the active-storage method for filing their engineering drawings.

Here, instead of storing the film and keeping the original handy for reference, it's the other way around. The original is stored. Microfilm becomes the reference copy.

This method also means the film copies are no longer stored on rolls. Instead, individual frames are cut from the roll and put directly into envelopes, or mounted in cards provided with an insertion hole. Such cards can be either the conventional 3 x 5 file type or EAM (Electronic Accounting Machine) cards. The EAM cards are most popular because they can be punch-coded and processed on standard accounting machinery to provide fast access and convenient storage.

What's to be gained

An active microfilm file in a completely mechanized system has all the advantages of roll microfilm plus a few more:

- Security—valuable drawings, representing many thousand dollars of drafting and engineering time, can be stored in compact film form in a disaster-proof area.
- Space-saving—depending on size of the originals and the reduction ratio used, microfilms can often be stored in less than 1% of the space needed for full-size tracings and prints.
- Labor-saving—if automatic sorting machines are used, desired drawings can be selected automatically. Drawings stored in a film file are small; easier to work with than the original tracing. Also, all drawings are filed sequentially, regardless of size of the original.
- Time-saving—engineers can get prints of microfilmed drawings in about a minute, and in even less time with automatic-feed, high-volume printers.
- Better reproduction—microfilm copies are often superior to contact copies: smudges and stains that show up when light is passed through the tracing will be hardly noticeable on microfilm—it photographs only the surface.

For engineering drawings, most common microfilm sizes are 35mm, 70mm, and 105mm. The 35mm frames are usually mounted in cards; 70mm and 105mm are stored in envelopes. Companies having many large drawings (aircraft and ship-

blade will slide the instrument over the board with ease and in parallel alignment. The T-square easily snaps out for change of paper.

Portable Drafting Machines are becoming smaller and more versatile—a boon for engineers who have to make accurate drawings on the spot. These are bona fide drafting machines that remain true at any setting over the complete area. Some can be folded to pocket size for carrying. Units sell as low as $6 complete with a 10 x 13-in. drawing board which can fit into a briefcase.

SENSITIZED MATERIALS

There is increasing interest nowadays in such "intermediates" as Sepias which function as second tracings and will (1) save wear and tear on valuable originals, 2) supply another plant with second originals (3) save time in mass-producing prints from one original, (4) supply duplicates of originals that are to be modified to customer specifications.

Intermediates are made as easily as prints and can be modified by washing out part of the original with a chemical, then drawing new lines or dimensions. This avoids making a new drawing, or marking up a print when a customer wants modifications in a product.

Intermediates can now be made from blue-line paper for more pleasing appearance, and from the moisture-proof new polyester film Mylar which has already made headway as an all-purpose drafting paper. It can take pencil, ink or typing and is almost indestructable (it cannot be torn by hand).

AND DON'T FORGET COMPUTERS

What engineers design, engineers can put to best use. Analog and digital computers are now an essential part of the design function. As time-savers, nothing can beat these robot mathematicians.

Biggest news in the industry is the simplified programming systems used to set up and run problems. Most

building, for example) or companies whose drawings show much busy detail, may choose the larger film sizes to get good working prints. Proponents of 35mm, on the other hand, claim large drawings can be reduced to 35 mm and still give prints as good as the original.

Who is using it

The advantages of microfilm vary, depending on size of the company. Very large corporations and government organizations have files active enough to allow them all the advantages of a completely mechanized system. The full battery of equipment is expensive but will save a large corporation enough money to more than offset the capital investment.

At other end of the scale, smaller manufacturers choose microfilm for only one reason—security. Microfilm, in this case, doesn't save money; it's an expense. But it's the only kind of insurance that will replace valuable drawings when they are lost, stolen or destroyed.

What about the "man in the middle"—the large-to-medium manufacturer? How big does the reproduction operation have to be to make a microfilm system more economical than standard diazo reproducing processes? Suppliers of microfilm and equipment are reluctant to quote a figure.

"It depends," they say, "on the number of drawings presently in the file, floor space occupied, labor involved, activity of the file, what the drawings are needed for, and—not to be underestimated—the ingenuity and experience of the engineer who sets up the system."

One thing is clear: It's not necessary to have several million drawings and a costly array of equipment to get—in a modest way—the cost-saving advantages of microfilm. For example, a company need not own a camera; microfilm service centers are spotted all over the country and will microfilm drawings—often on a same-day basis. Cost here depends on film size, quantity ordered, and intended use.

The system

Once the user has microfilms in his file, he has two ways to put them to work: He can turn them into enlarged copies (called "blow-backs"), or he can make duplicate film copies. The film copies can be made somewhat faster than the enlargements. They are small; the engineer can put many in his desk drawer; they can be easily mailed or carried around. Blow-backs, on the other hand, are often preferred because they don't require a viewer—can be used in the same way that contact copies of the tracing have served in the past.

Both types of copies can be made on a customer-service basis, but to take full advantage of an active microfilm file, most plants will prefer to have their own reproducing equipment. Blow-backs can be made on photographic paper, with standard photographic darkroom techniques, but this is expensive. There are a number of enlarging machines, however, that expose and develop the blow-back within the machine, without need for a darkroom. The principle is similar to that of photographic processing but is much quicker and less expensive—to the point of being almost competitive with diazo contact prints from the original drawing.

In addition, there are other enlarging machines—some only recently on the market—that operate on electrostatic or diazo principles and promise further savings in operating cost. One cost-saving feature when printing from microfilm: Satisfactory working prints needn't be full size, saving considerably on paper costs.

Duplicate film copies printed from 35mm microfilm require a reader for convenient inspection; 70mm and 105mm films can sometimes be scanned simply by holding them to the light. Readers, in many styles, are available for all sizes. Some, of the projection type, give an enlarged image on a translucent screen, others are simply handheld magnifiers and the image is viewed with room light.

Convenience at the drawing board

Draftsmen find microfilm convenient, and time-saving too. No longer is it necessary to roll and unroll bulky tracings on a reference table. A projection viewer at the desk side gives an easily viewed image to work from. And tracings of microfilmed drawings can be made quickly on a special ,translucent-topped drafting table which shows a full-size image, projected from underneath, on the working surface.

Microfilm is growing fast. New equipment is announced almost every month and operating costs decline steadily. This means microfilm and its inherent advantages are coming within reach of the pocketbook of many companies.

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engineers have neither the time nor the patience to learn the complexities of programming or patch-boarding and computer manufacturers, too, have found programming their biggest time-consumer.

So automatic and self-programming computers have been getting more attention—and with considerable success. Now, general-purpose digital computers can be operated by junior engineers after two hours of instruction and practice. Smaller models will fit easily in any engineering office, and cost in the neighborhood of $50,000. You can rent large computers by the minute and even have packaged problems solved for as little as $30 (see *PE—June* 2 '58, *p* 28).

On the horizon, most exciting is a report from Cornell Aeronautical Lab which describes the Perceptron—a machine capable of perceiving, recognizing and identifying its surroundings without human training or control. While now in its very early stages, an artificial brain of this kind could not only read print or script, respond to verbal commands, and translate languages—but even go on to navigate space ships and ultimately represent man in the exploration of inhospitable planets.

—NICHOLAS CHIRONIS, *Associate Editor*

EDITOR'S NOTE: For more on how labor-saving equipment and techniques will pay off, see "Reducing Costs in the Drafting Room," June '55, p 193—nine areas where money can be saved.

Efficiency is also increased by instructing draftsmen to draw only essential lines. This approach is described in: "Functional Drafting . . . Another Viewpoint," Feb '57, p 199, and "Simplified Drafting—Pro and Con," July '56, p 200.

Criteria for selecting reproduction equipment are given in "Choosing Equipment for Drawing Reproduction," Jan '57, p 135.

Behind the need for efficiency are mounting costs. See "Drafting Costs Going Up," June '57, p 166, for point-by-point comparison of costs in 1935 with the present.

Eyecatching displays . . .
alert the engineering staff-member to newly published material and draw him into the library.

Even if it concentrates on one subject, your company library can't hope to compete with the Library of Congress. Being relatively small, it must get the most out of the facilities it can afford. Here's a guide to . . .

MORE SERVICE FROM YOUR COMPANY LIBRARY

You walk into your company library. You are looking for only one thing—information. Today you want a phase diagram for gold-aluminum alloy—or a magazine article you remember reading several months ago. What you need tomorrow may be the latest information on a lubricant for nylon bearings, or the name of a manufacturer of Teflon O-rings. And the library that provides the precise information in the shortest possible time . . . that's the best library.

To give such service a library can get by with modest physical assets; very few can afford to stock all the books covering even a very narrow field. But although a small library is limited in capital equipment it can supply the engineer with all the information he needs—if the librarian energetically exploits and develops all resources at her command.

But simply getting the facts, quickly and accurately, is only part of the well-run library's job—the passive part. It will also actively reach out to the engineer, without being asked. It will pass on information he may need, encourage him to bring in his problems, stimulate his thinking with information he might otherwise miss. Performing this two-part service adds up to a big job.

When Information Is in the Library . . .

As in all other types of libraries, the card catalog is key to needed information. But a small company library must go beyond the usual cataloging of books and pamphlets by subject, title and author cross-references. Literature must be scanned with company projects in mind, and pertinent facts either cataloged or abstracted on file cards. Ideally, every fact worth storing on library shelves should be instantly available—that ideal is difficult if not impossible to attain. But an efficient, comprehensive catalog system should be the goal of every company librarian.

Periodicals for the current year should be stacked on easily accessible open shelves. Abstracts of selected articles should be printed on catalog cards, then filed by subject and author. This file helps locate articles you "remember reading" but aren't sure when or where; more important, it will quickly find all available articles on a given subject.

Books and pamphlets will be filed, of course, according to accepted library techniques—Dewey Decimal System, Library of Congress System, or whatever. In addition, subject cards must be handled in detail with emphasis on the subject content of each book. One book may spawn many subject cards with page numbers noting where the specific information can be found.

Commercial literature, such as catalogs, bulletins, data sheets, is arranged alphabetically in some libraries, by product in others. Another convenient way is to assign each manufacturer an arbitrary file number, and to place all company literature under this number. Two file cards are made. One lists file number, name and address, and local company representative; and on the reverse side, products under which the company is listed. This card is filed alphabetically with other company cards. The other card is a cross-index, filed alphabetically by product, listing companies and their corresponding file number. Filing by number allows adding a new catalog without rearranging the file.

In a small library the three sets of cards—one for periodicals, one for books and pamphlets, and one for company catalogs—can all be placed in the same cabinet. Its separate sections permit two or more persons to search simultaneously for information. The system is so simple that do-it-yourselfers can help themselves to a magazine or book in the librarian's absence, recording title and number on conveniently placed or easily accessible check-out cards.

Other Services

To give full service, small company libraries must expand other typical services too. Some things to do are:

- Prepare bibliographies on any subject requested by an engineer. Also collect any listed reference material.
- Scan magazines for new products in the company's field and for literature offered by competitors or companies in related fields.
- Check catalogs and company data-handbooks periodically to be sure the latest are on file.
- Offer to order books and magazines through the library. This is not only a convenience for employees, but avoids duplication and allows the company to benefit from the economy of central purchasing.
- Keep a "list of interest" file for all staff engineers. If the librarian knows what topics interest each staff

No Library?—Some Tips on How to Begin

Perhaps the first step for the newcomer is to contact the Special Libraries Association. This organization, with 31 chapters in the US and Canada, is a group of libraries owned by manufacturing concerns, banks, law firms, insurance agencies. A letter addressed to the main office at 31 E. 10th St., New York 3, N. Y., will put you in contact with the chapter in your area. Each chapter maintains a staff consultant who, for a fee, gives advice on how to set up your library. Consultants have had much experience helping small technical libraries get started and will answer: How many books are needed? How much space? How large a staff? What will it cost?

Next step is to find a librarian. Even a small library should be run by a trained librarian who will organize literature so that it is readily accessible, and do the most with available resources. Special Libraries Association can help here too—with its placement service for personnel trained in Library Science. But be patient. It may be several weeks before you can find the librarian with training and background you require.

Until the Doctor Comes

Here are some quick answers a trained librarian or special consultant can be expected to develop in detail:

Location

The new library, preferably in a room by itself, should be within easy reach of research and development personnel and away from noisy areas. Books are heavy—about 140 lb per sq ft for a bookshelf seven shelves high—so take this into account when planning floor space. Allow room for expansion too. It's estimated that the library with 1000 books today will contain over twice that many eight years from now. Stacks of periodicals alone grow at the rate of about 7 in. per year. The room should be air conditioned and all reading surfaces illuminated with 40 to 60 ft-candles of shadowless light.

Cost

This depends, of course, on size of the library, which depends in turn on size of your organization and breadth of the technical field involved. As a starter, 1000 books is average. This means a floor area of between 600 and 1000 sq ft—including space for desks, filing cabinets, reading tables. Such a setup would probably require one full-time librarian and an assistant. Initial outlay for books and office equipment would be about $5000, of which perhaps half would go for equipment, one-third for books, the remainder for subscriptions and miscellaneous supplies. You can save money by rounding up company-owned books, presently scattered around the building in the private libraries of your engineers.

Yearly budget would be about $10,000-12,000 (not including heat, light and rent and other overhead items). The bulk of this will pay salaries of librarian and assistant. Out of the total, also figure on spending about $1500 for new books and $200-300 for subscriptions.

member, publications can be screened and items of particular interest sent immediately without waiting for a request. This list should be revised every six months to keep it up to date.

- File engineering notebooks and research reports. One central file permits quick checking, especially where several staffs and laboratories are involved.
- Make patent searches and collect patent information when the company has no patent department to do this job. Patent searching is specialized work, but many company libraries have become proficient at it. Thousands of dollars can be saved if a search is made before filing a patent claim or starting a new project.

When the Library Needs Help . . .

There are a number of external sources for books and periodicals which, in effect, expand the fund of information upon which a small library can draw.

Commercial abstracting and indexing services provide quick reference to many more publications than most libraries can have on their shelves.

Technical societies usually maintain some kind of technical library. Perhaps the most extensive of these, as well as one of the most complete technical libraries in the country, is the one in the Engineering Building in New York City. Here are the collected libraries of many engineering societies. Branch offices of technical societies in cities all over the country also maintain their own libraries.

Nearby company libraries are another source. Two neighboring libraries often agree to concentrate on fields of peculiar interest to their engineers and reduce or eliminate overlapping holdings. This way, one library may stress electrical engineering, the other the physical sciences, with an arrangement to borrow freely when necessary. Together, they can answer many more requests and stretch book budgets farther.

Reaching Out—the Active Library

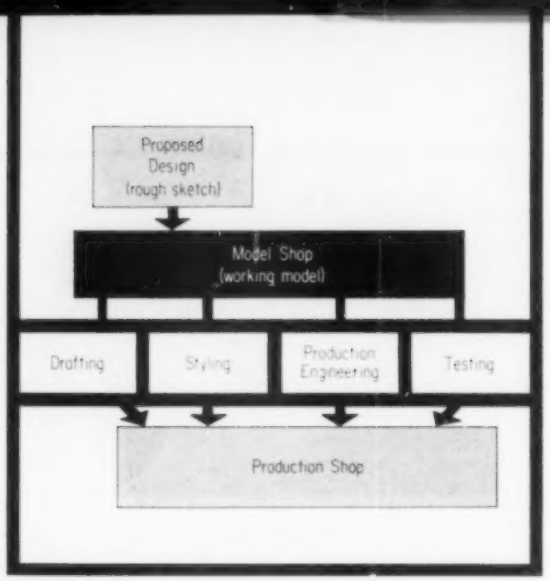
Besides expanding the services normally provided by any library, a company library must extend activities to meet the engineer more than halfway, providing him with technical information and making him aware of available facilities.

Library displays, exhibiting recent acquisitions or showing sample material keyed to some area of current interest, will often help draw the engineer into the library. These should be placed prominently in the main stream of traffic where technical personnel are certain to see them. A number of books and pamphlets on plastics, for example, could be displayed to show increasing impact of this material on a company making pipe fittings. Sometimes needed data is found right on the display table.

Library publications keep technical personnel aware that the library is standing by, ready to help. Library notes, circulated to all engineers describe new books and pamphlets available on loan. Other memos should be sent out periodically: some to announce new library facilities, services or procedures; others to suggest new uses for existing facilities .

RUTH R BOYLE and ROBERT C MAY
Automatic Switch Co

The time-saving step . . . between design board and production shop is the model shop. Flow chart shown at right will vary from company to company.



Far from being just a playroom for engineers and would-be machinists, the model-making shop can save time and money, result in cleaner designs. From a survey of several industrial model shops, we've gleaned these tips that will help you organize or improve your own shop.

. . . FOR FASTER NEW-PRODUCT DEVELOPMENT
. . . FOR CLOSER PRODUCTION SCHEDULING

If you're still on the fence about setting up a model shop, consider the development time it will cut down and the production facilities it will set free from development demands. Engineers can develop new products faster with trained modelmakers helping them; production men can schedule more accurately if they don't have to warp their schedules to build time-consuming prototypes. And something else: a model shop close by will show the engineer what can be done with his ideas—and what cannot.

To start a model shop properly, you must first define its job. Is it primarily for research and development; for producing production prototypes; or for making test quantities of new items?

The answer is simple. Unless financially impossible, limit your shop to making one-of-a-kind DEVELOPMENT items. This way you won't face the interference that non-engineering jobs involve.

Offbeat work, of course, cannot always be avoided. Model shops fall heir to odd jobs like turning out two dozen relays, or miniature gear trains for wear testing. Sometimes the model shop is best equipped to handle such work because the modelmakers are already acquainted with the design, tolerances, and materials required. But when a production-type job threatens to take more than a week, it should be farmed out.

SELLING THE IDEA

Despite its time- and cost-saving features, a model shop may look like a pretty inefficient operation to men from the accounting department. Expensive machinery sitting idle . . . costs unpredictable . . . schedules not precisely set up or maintained . . . irregular man-hours. So, convincing the wary and getting the project going is sometimes a real problem.

One way is to start modestly: collect a few pieces of equipment and expand as money and workload allow. "We had to sneak in a drill press and a lathe," says one model-shop manager. "We were able to prove that the equipment helped get a cleaner design, quicker and less expensive in the long run." After initial spade-work has been done this way, skeptics can often be persuaded to loosen up the purse strings a bit for additional equipment.

ESTIMATING SIZE

But suppose everyone agrees that a model shop is a valuable facility. Next questions are: "How big should it be?" and "Where should it be located?" Most companies put the shop as close to the engineering staff as it can be without actually causing a physical disturbance. This reduces length of flow path for the stream of information passing from engineer to modelmaker.

How much equipment, floor space and personnel you will need is not as easily answered. It will depend, of course, on the type of product you are developing and the number of engineers the shop is to service. A rough estimate, based on figures from several firms with small model shops, is to provide one modelmaker for each six or seven R & D men. The number of machines, in turn, depends on the number of modelmakers.

Because work here does not flow smoothly from one machine to the next, it is common to allow more floor area per machine than in a production shop—roughly the same area allowed in the tool shop. A staff of 12 engineers would need about two modelmakers in a shop of about 1000 sq ft. Typically, a shop this size might have two or three drill presses, two lathes, a milling machine, surface grinder, kick press, brake, bandsaw, and a variety of small power and hand tools.

A more scientific way to determine size is to keep records on the amount of development work being subcontracted or done in the production shop. These figures in man-days give the approximate number of modelmakers you will need. But keep the figures conservative.

Modelmaker and engineer . . .
blend skills as they turn ideas on paper into working hardware. The engineer becomes better acquainted with machine techniques; the modelmaker, better able to understand engineering needs.

Precision parts . . .
from a rough sketch are the modelmaker's specialty. These are components of microwave crystal multiplier cavities for use in Western Union Telegraph Company's radio beam system and made in its D & R Laboratory Model Shop.

BUILD A MODEL SHOP

Trained modelmakers cost money—20 to 25% more than ordinary machinists—and a shortage of machinery, in the first estimate, is better than an excess.

QUALITY: IN MEN AND EQUIPMENT

When buying machinery, choose only top-grade toolroom equipment. Production tools are usually too specialized and too inflexible for modelbuilding. Precision equipment is necessary because accuracy is important in the first model. After it is built and tested, engineers can specify which dimensions are critical and which can be loosened a little.

The first estimate for amount of machinery should assume that specialized jobs will be farmed out—it's cheaper that way. Even the largest model shops subcontract specialized jobs and arrange for outside shops to do ordinary machine work during peak loads. Most companies would be unwise, for example, to include plating and engraving equipment, or buy casting and patternmaking facilities. It's better to invest the company's equipment money in more basic items.

The model-shop staff should not, as a rule, be recruited from the production shop. Production workers are not accustomed to one-piece jobs and usually don't have the required skill on a variety of machines. In a production process the machine is the center; in making models, the man is the center. He is a skilled artisan who can use any machine or tool; will occasionally improvise one for a special need.

On the other hand, highly skilled modelmakers are difficult to come by. Ideally they should be men with production background and versatility acquired as toolroom machinists. If you are going to make mockups and appearance models, you will want men who are skilled workmen in all media—from clay to metals.

Often the best way to get them is to develop them yourself. One large shop conducts a 4-year training course for its machinists-turned-modelmakers. Once trained, these men have the same value to the company as a new graduate engineer—and should be rewarded about equally. A modelmaker's wages cannot be tied to productivity as with a production machinist. He must be paid commensurate with his skill.

WHO'S IN CHARGE

The engineering department should manage the model shop for two reasons: This gives the engineers priority, and it allows them to become familiar with the problems involved in producing a given piece of equipment.

There's one disadvantage to control by the engineering department: This usually means the model shop is included in the engineering budget. And this will some-

Full-scale appearance models . . .
and mockups, from ballpoint pens to giant electronic computers, are built in this shop maintained by Sundberg-Ferar, Inc, industrial designer. Skilled craftsmen can work in any medium: wood, clay, plaster, metal.

Model-building facilities . . .
can range from two or three machines in the corner of production shop to a large-scale shop like this one. It is at the Western Electric Engineering Laboratories, Winston Salem, NC.

WHAT GOES INTO A MODEL SHOP?

Most shops have these tools:	Some have these optional extras:
milling machines	optical comparators
bench lathes	spot welders
arbor presses	jig borers
sheet metal working machines	jigsaws
drill presses	hobbing machines
surface grinders	heat-treating furnaces
tool grinders	engraving machines
bandsaws	jeweler's lathes
welders	woodworking machines
	painting and plating equipment

times hold down the size of the shop, both in terms of equipment and employes, or lead to substituting machinists for the more-expensive modelmakers.

Although his department may be in charge of the shop, an engineer's access to shop machinery can be a major question. Generally, you'll do well to have the engineer as familiar as possible with shop operation, because this will promote more economical design: If an engineer machines a part himself, he's much more likely to be aware of the production problems involved and he may come up with a cleaner, simpler design because of it.

On the other hand, most companies don't want engineers actually taking a crack at the expensive modelmaking machinery. Such men are considered insufficiently skilled for high-quality machine work, and using engineering time this way is therefore wasteful and inefficient. Other drawbacks: Engineers who are careless or unfamiliar with the machinery are a poor safety risk; shop unions usually don't allow non-union workers to operate machines.

Some large R & D laboratories solve the problem another way. They keep the engineer out of the main model shop but give him a small floor shop where he can fuss with the machinery himself. This makes sense where the main model shop is very large because, generally, the larger the shop the more procedural red tape and the poorer the service.

Adding a small floor shop is, of course, more expensive but a large laboratory can make it pay. Small organizations sometimes do pretty much the same thing on a smaller scale. They have an old lathe, a drill press and a drawer full of hand tools off in a corner somewhere, specially reserved for engineers. If it's a simple job like turning down a small shaft or drilling a few holes, the engineer can do it himself and be back at his desk in minutes.

THE MODEL BEGINS

In the ideal model shop, an engineer would enter with a precise, well-analyzed design, and hand it to a modelmaker who would turn out a production prototype. A more common approach is to build a model from a rough freehand sketch, "sometimes on a paper towel," as one director puts it. The machinist or modelmaker is free to recommend changes to the engineer, who incorporates them into the existing drawings. As each part of the model is finished, the drawing for that part should be forwarded to the drafting department, so that the working model and a book of drawings are finished almost simultaneously.

Of course, you can set up shop procedure as formally or informally as you please. Generally, larger shops are more formal than those where engineers can just walk in and tell a machinist what they want. Most shops require at least a freehand drawing with some dimensions and tolerances indicated; more detail would be superfluous, since design and model often change several times before a prototype is produced.

Throughout the modelbuilding operation, engineer and modelmaker should consult freely over progress and possible design changes. Close cooperation here between engineer and modelmaker is essential to dovetail scheduling. If a part proves tougher to develop, the engineer can channel the model shop's efforts accordingly so the part will not hamper construction of the entire model. For this reason, most shops assign a modelmaker who will work along with the project from start to finish.

In addition to communication between modelmaker and engineer, there should be liaison between model shop and production shop. This will help give production people as much advance information as possible in preparation for the time when the model becomes a production item.

—W E BOGGS

EDITOR'S NOTE: Models can be reduced scale replicas, full-size appearance items, or one-of-a-kind mechanisms which prove design principles. "Models Show How . . .", Sept. 16 '57, p 99, describes various kinds of models and tells how they helped save thousands of dollars plus countless manhours.

A combined reprint including the series of articles on "Why Modernize," in the R & D Issue last week, and this series on "How to Modernize" is now available. Copies may be obtained at 50¢ each, as long as the supply lasts, by writing Reader Service Manager, Product Engineering, 330 W 42nd St, N Y 36. Ask for "Plan '59" reprint.

METHOD of FINITE DIFFERENCES

another way to differentiate curves

Suppose you're designing a cam and don't have its equation of motion. To find its velocity and acceleration characteristics you can use the old-fashioned graphical way—drawing tangents to the motion curve. But here's a numerical method of approximations that gives more accuracy.

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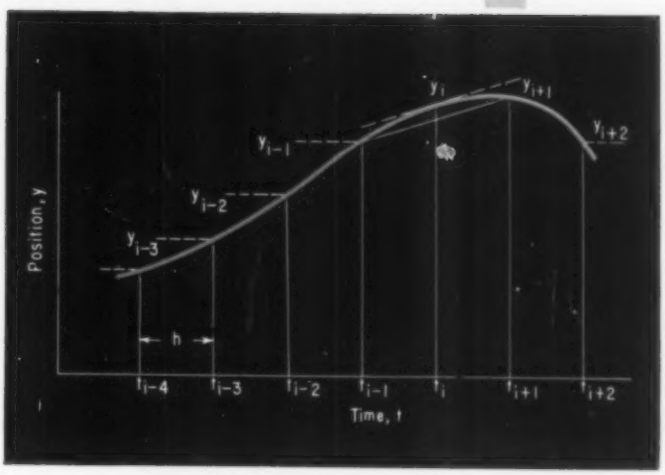
IRVIN KRAUSE
Lecturer, City College of New York



Tangent at point y_i . . .
is approximated in numerical method by slope of line joining two adjacent points y_{i-1} and y_{i+1}. Method also includes use of four adjacent points for greater accuracy.

Here is a simplified method for numerically differentiating an equation or function defined solely by means of tabulated data. Although the results are approximate they are far more accurate than by the common graphical method in which tangents are drawn at a number of points along the curve being analyzed.

A frequent need for such differentiation is in linkage and cam design where the positions of a point on a rotating mechanism have been plotted as a function of time (or cam angle, crank angle, etc). Differentiating the time-displacement values will give a velocity diagram from which the acceleration diagram can then be developed.

The differentiation method given here is a purely mathematical one involving finite differences. Two equations have been derived for the method—one for finding the velocity components, the other for finding acceleration components, directly from the displacement data—an operation not possible with graphical methods. If still more accurate values are wanted, they can be found in a little additional time from a second set of helpful equations.

Although the method is tabular and numerical, it does have a graphical analogy, shown above for a curve whose slope equation is unknown.

Generally, numerical values are known for uniform time intervals h (this may be at every 15° of cam angle). To find the velocity component of a point y_i, join a line between the two nearest points, y_{i-1} and y_{i+1}. This line will be closely parallel to the true tangent at y_i, hence can be used as the tangent to give the velocity component. The method of finite differences follows the same concepts—but with equations instead of graphically.

These equations are:

• Eq (1) gives the velocity component y′ directly without need for graphical construction. Thus

$$y_i' = \frac{y_{i+1} - y_{i-1}}{2h} \qquad (1)$$

• Eq (2) gives the acceleration component y″ directly from the positional data of the point—thus avoiding a buildup of errors:

$$y_i'' = \frac{y_{i-1} - 2y_i + y_{i+1}}{h^2} \qquad (2)$$

• Eq (3) and (4) involve four adjacent points, thereby giving closer approximations. The velocity component is:

$$y_i' = \frac{y_{i-2} - 8y_{i-1} + 8y_{i+1} - y_{i+2}}{12h} \qquad (3)$$

and the acceleration component is:

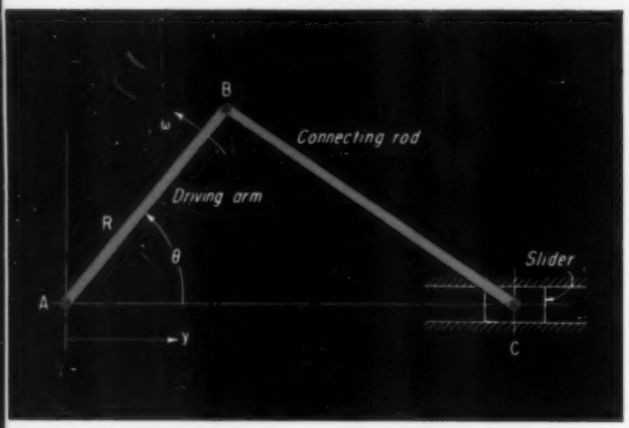
$$y_i'' = \frac{-y_{i-2} + 16y_{i-1} - 30y_i + 16y_{i+1} - y_{i+2}}{12h^2} \qquad (4)$$

APPLICATION TO SAMPLE PROBLEM

Velocity and acceleration characteristics of a slider

COMPARISON OF ACCURACY GIVEN BY DIFFERENTIATION METHODS

POSITION OF DRIVING ARM θ, deg	POSITION y, in.	VELOCITY, IN./SEC			ACCELERATION, IN./SEC^2		
		First Finite Difference Eq (1)	Second Finite Difference Eq (3)	Exact Method, Eq (6)	First Finite Difference Eq (2)	Second Finite Difference Eq (4)	Exact Method Eq (7)
0	11.0000	0.0000	000.000	000.000	−41,174	−41,483	−41,250
15	10.8594	−103.839	−105.845	−105.906	−38,300	−38,611	−38,868
30	10.4563	−195.646	−199.313	−199.593	−31,894	−32,159	−32,020
45	9.8350	−265.452	−270.341	−270.471	−21,492	−21,635	−21,655
60	9.0664	−305.922	−311.120	−311.316	− 9,425	− 9,400	− 9,403
75	8.2332	−315.204	−319.854	−319.950	2,334	2,518	2,487
90	7.4160	−296.582	−300.087	−300.000	11,891	12,197	12,136
105	6.6803	−257.755	−259.614	−259.602	17,771	18,041	18,016
120	6.0664	−207.774	−208.407	−208.302	20,412	20,610	20,597
135	5.5924	−153.992	−153.868	−153.765	20,674	20,766	20,772
150	5.2601	−100.955	−100.662	−100.407	19,843	19,816	19,941
165	5.0638	− 49.676	− 49.408	− 49.386	19,332	19,349	19,088
180	5.0000	000.000	000.000	000.000	18,617	18,498	18,750



Sample problem . . .
in this article is based upon slider-crank mechanism above, where R = length of driving arm AB, L = length of connecting rod BC. Angular velocity ω of driving arm is assumed constant; y axis is taken along direction of motion of the slider, originating at A.

crank, diagrammed above, are analyzed by using first- and second-difference expressions and then comparing results with those obtained in an exact analysis.

When curve's equation is known

The exact solution, of course, calls for knowing the equations that give displacement, velocity and acceleration of the slider crank. These equations are:

Displacement of slider in terms of the angular position θ of the driving arm is:

$$y = R\cos\theta + L\sqrt{1-\left(\frac{R}{L}\sin\theta\right)^2} \qquad (5)$$

Velocity of the slider is the first derivative of Eq (5) with respect to time. Thus, since $\omega = d\theta/dt$,

$$y' = \frac{dy}{dt} = -R\omega\left[\sin\theta + \frac{R\sin 2\theta}{2L\sqrt{1-\left(\frac{R}{L}\sin\theta\right)^2}}\right] \qquad (6)$$

Acceleration of the slider is equal to the second derivative of Eq (5), and since $d\omega/dt$ is zero (because ω is constant), the acceleration y'' is equal to:

$$y'' = \frac{d^2y}{dt^2} =$$

$$-R\omega^2\left[\cos\theta + \frac{\left[\frac{R}{L}-\left(\frac{R}{L}\right)^3\right]\cos 2\theta + \left[\frac{R}{L}\right]^3\cos^4\theta}{\left[1-\left(\frac{R}{L}\sin\theta\right)^2\right]^{3/2}}\right] \qquad (7)$$

For a particular mechanism, where $R=3$ in. and $L=8$ in., the exact values are shown in the accompanying table for every 15° of rotation and for a crank speed of 100 rad/sec. Because of the symmetry of the problem, results were tabulated only for the first 180° of crank rotation.

When You Lack Curve Equations

By using the appropriate finite-difference equations, Eq (1) to (4), you can evaluate the velocity and acceleration of the slider directly from the displacement values, Column 2 in the table. Thus you avoid deriving Eq (6) and (7) nor need you solve these complex equations.

For example, at $\theta = 15°$, y_i corresponds to position of the slider at $\theta = 15°$, while y_{i-2}, y_{i-1}, y_{i+1}, and y_{i+2} correspond to its position at $\theta = -15°$, 0, 30° and 45°, respectively.

Thus, according to the table:

$$y_i = 10.8594, \quad y_{i-2} = 10.8594, \quad y_{i-1} = 11.0000,$$
$$y_{i+1} = 10.4563, \quad y_{i+2} = 9.8350$$

Numerical values of y_{i-2} and y_i are equal because of the symmetry of the problem. According to the first finite difference, Eq (1), the velocity of the slider is:

HOW TO DERIVE THE EQUATIONS

The position of any point in a mechanism may be expressed as a function of time; $y = y(t)$. For any real mechanism the function $y(t)$ is continuous and so are its derivatives. One may, therefore, write Taylor's series to compare the values of the function at t and $(t + \Delta t)$, or t and $(t - \Delta t)$.

$$y(t + \Delta t) = y(t) + (\Delta t)\frac{dy(t)}{dt} + \frac{(\Delta t)^2}{2!}\left(\frac{d^2y(t)}{dt^2}\right) + \frac{(\Delta t)^3}{3!}\left(\frac{d^3y(t)}{dt^3}\right) + \cdots$$

and

$$y(t - \Delta t) = y(t) - (\Delta t)\frac{dy(t)}{dt} + \frac{(\Delta t)^2}{2!}\left(\frac{d^2y(t)}{dt^2}\right) - \frac{(\Delta t)^3}{3!}\left(\frac{d^3y(t)}{dt^3}\right) + \cdots$$

Denoting the particular time to be investigated as t_i and the value of y at this time as y_i, then the time "stations" to the left of t_i are t_{i-1}, t_{i-2} . . . and to the right of t_i are t_{i+1}, t_{i+2}, . . . Corresponding values of y are denoted by y_{i-1}, y_{i-2}, . . . and y_{i+1}, y_{i+2}, . . . respectively.

With this notation, with Δt set equal to h, and by only including the first three terms, Taylor's series can be simplified to read:

$$y_{i+1} = y_i + hy_i' + \frac{h^2}{2!}y_i''$$

$$y_{i-1} = y_i - hy_i' + \frac{h^2}{2!}y_i''$$

where the prime marks indicate differentiation with respect to time. Subtracting one from the other gives an equation for the first derivative of y, which is the velocity of the point

$$y_i' = \frac{y_{i+1} - y_{i-1}}{2h}, \qquad (1)$$

whereas their addition leads to the second derivitive of y, which is the acceleration of the point

$$y_i'' = \frac{y_{i-1} - 2y_i + y_{i+1}}{h^2} \qquad (2)$$

Eq (1) and (2) are called first finite difference expressions because they were derived by neglecting all derivatives in Taylor's series that are higher than the second. If some higher derivatives are retained, equations can be developed which give more accuracy. By including the third and fourth derivatives, the Taylor's series becomes:

$$y_{i+1} = y_i + hy_i' + \frac{h^2}{2!}y_i'' + \frac{h^3}{3!}y_i''' + \frac{h^4}{4!}y_i^{iv}$$

$$y_{i-1} = y_i - hy_i' + \frac{h^2}{2!}y_i'' - \frac{h^3}{3!}y_i''' + \frac{h^4}{4!}y_i^{iv}$$

$$y_{i+2} = y_i + (2h)y_i' + \frac{(2h)^2}{2!}y_i'' + \frac{(2h)^3}{3!}y_i''' + \frac{(2h)^4}{4!}y_i^{iv}$$

and

$$y_{i-2} = y_i - (2h)y_i' + \frac{(2h)^2}{2!}y_i'' - \frac{(2h)^3}{3!}y_i''' + \frac{(2h)^4}{4!}y_i^{iv}$$

where, in keeping with the current notation, $y(t + 2h) = y_{i+2}$ and $y(t-2h) = y_{i-2}$. The difference between these expressions is

$$y_{i+2} - y_{i-2} = 4hy_i' + 2\frac{(2h)^3}{3!}y_i'''$$

from which the velocity of the point is:

$$y_i' = \frac{y_{i-2} - 8y_{i-1} + 8y_{i+1} - y_{i+2}}{12h} \qquad (3)$$

and the acceleration is:

$$y_i'' = \frac{-y_{i-2} + 16y_{i-1} - 30y_i + 16y_{i+1} - y_{i+2}}{12h^2} \qquad (4)$$

Eq (3) and (4) require knowing four adjacent points.

$$y' = \frac{10.4563 - 11.0000}{(2)\left(\frac{2\pi}{360}\right)(15)\left(\frac{1}{100}\right)} = -103.839 \text{ in./sec}$$

According to the second finite difference, Eq (3), the velocity is equal to −105.845 in./sec. These may be compared with the exact value of −105.906 in./sec listed in the table. The results of similar calculations carried out for 15° intervals, are shown in the table.

Acceleration of the slider can be found directly from the displacement data. When the numerical values for $\theta = 15°$ are introduced into Eq (2), the first approximation for acceleration is −38,300 in./sec², whereas form Eq (4) the second approximation is −38,611 in./sec². The exact acceleration is −38,868 in./sec².

COMPARISON OF RESULTS

Thus numerical results obtained by finite-difference methods differ only slightly from those obtained from the exact solution. It appears that Eq (1) and (2) are sufficiently accurate for most mechanism analyses. However Eq (3) and (4) will give greater accuracy although they double the work.

For still greater accuracy, smaller time intervals can be chosen or the derivation of the equations can be refined to include higher terms of the Taylor's series expansion.

Equations can also be developed to include only the stations in advance of the one under investigation. They are known as forward finite-difference equations and are helpful where data before the first station is unavailable. Also, equations can be written in terms of stations entirely behind the one under investigation or even in terms of unequally spaced stations.

EDITOR'S NOTE: For a simplified but surprisingly accurate method for performing graphical integration see "Simplified Graphical Integration," Aug '56, p 223. The method requires only a couple of triangles and a pencil.

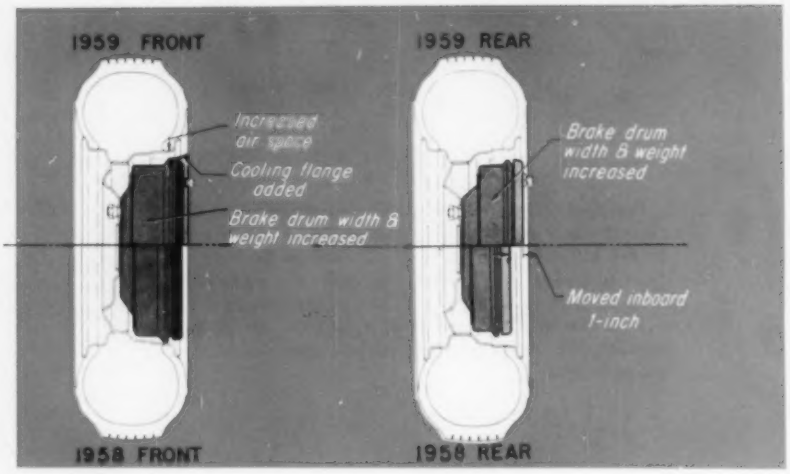
Another approach to differentiating or integrating a set of points is to find an equation that will fit the data. For a shortcut method making use of reference tables see "Curve Fitting With Orthogonal Polynomials," Apr '56, p 171.

it's already 1959 in DETROIT

There have also been engineering changes in the '59 cars, even though the new models continue emphasis on styling—and sales problems have dominated most of the past year's thinking in the world's auto capital.

Shown on these two pages is a sampling of the '59 improvements—modification of existing suspensions, better brakes and shock absorbers, more work for servos. The attention to suspension and braking reflects impact of foreign and sports cars on the US market. Such changes are evolutionary—nothing drastic can be expected until next fall's '60 models show what's being done to produce smaller cars and eliminate or reduce the drive-shaft tunnel.

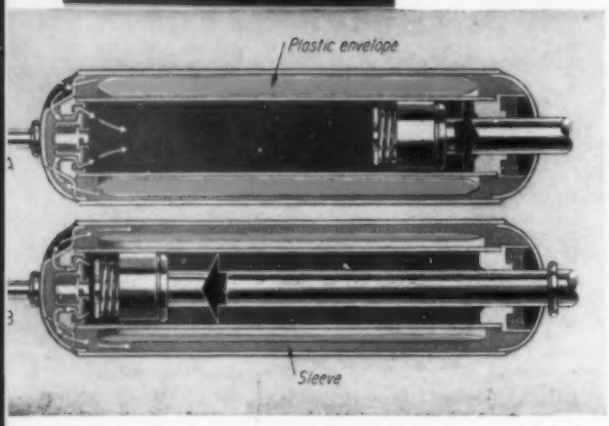
Meanwhile, the length, width and horsepower of most '59 models has been increased—and prices will undoubtedly keep pace.



PONTIAC

Bigger brakes . . .
and improved brake cooling are mechanical features of the new Pontiacs. A 1958-1959 comparison shows increase of 9.4% in brake area and 39% in brake-drum weight. Moving the rear brakes inboard 1 in. provides additional air space for heat escape. Flanges on the front brake drum act as scoops to force cool air over the unit. This should help solve brake-heating problems caused by smaller tires and wheels used in the past few years.

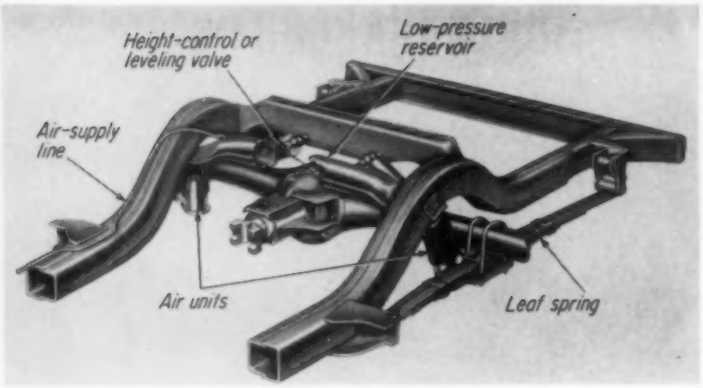
CADILLAC



Accumulator principle . . .
is used in '59 shock absorbers to assure Cadillac's famed easy ride. Plastic envelope filled with Freon 12 is placed in enclosing sleeve, and expands or contracts to keep oil under pressure at all times.

As plunger is pulled to bottom of cylinder (A), gas in envelope expands, forces oil through ports to eliminate air pockets behind piston. When car hits a bump, piston is forced up in cylinder (B), oil flows through ports into sleeve and compresses plastic envelope. Spring-controlled orifices control flow of oil through piston.

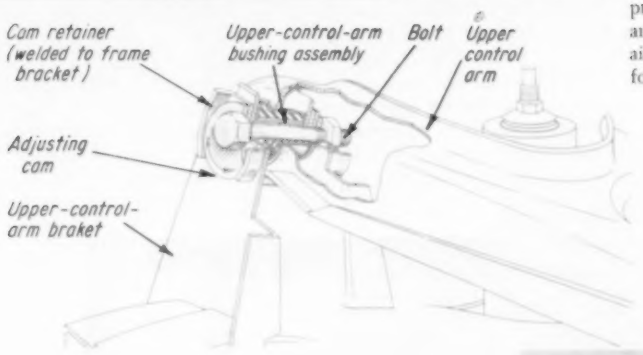
IN NEW PRODUCTS



CHRYSLER

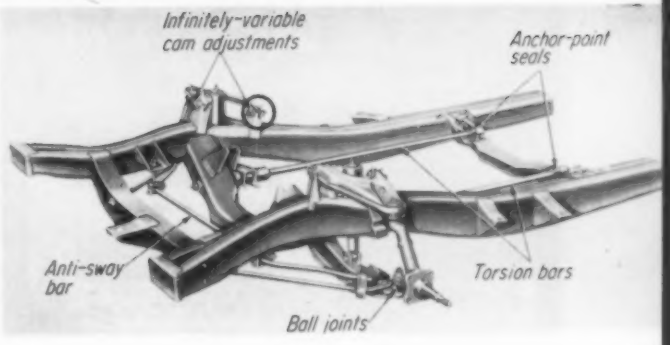
Automatic leveling . . .
keeps rear of '59 Chryslers at same level regardless of variations in load. Engine-driven compressor supplies air at 220 psi to a high-pressure tank (not shown). Automatic-leveling valve reduces this pressure, delivers low-pressure air to a reservoir connecting two air units. When car is empty, air units support approximately 300 lb on the rear axle; remaining load is handled by the leaf springs. Leveling valve, mounted on low-pressure reservoir, is connected to rear axle by a flexible link.

As load on rear end increases, body approaches the axle; flexible link opens the valve, raising pressure in the low-pressure reservoir. Car body now rises and closes the valve. This combination of leaf spring and air suspension provides many advantages: constant ground clearance; head and back-up lights are always properly aligned; and if the air units fail, the leaf springs provide sufficient support for normal driving.



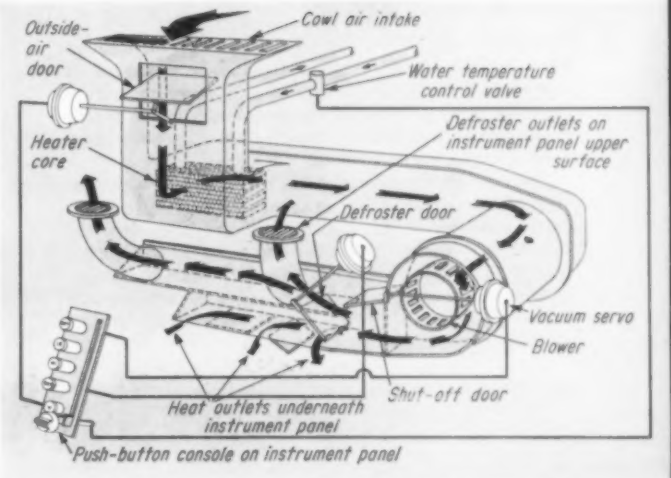
Cam adjustment . . .
of camber and caster, introduced on Chrysler products, is more precise than previous shim system—and promises improved steering and increased tire life. Rotating either front or rear cam adjusts caster setting. To alter camber, both cams are rotated required number of degrees.

Another change: New ball joint has spiral grooves on bearing face; normal up-and-down movement of front suspension forces lubricant between ball and socket. Improved lubrication reduces friction and ball-joint wear, eases steering.



Pushbutton weather . . .
is made possible in '59 Chryslers with servos that control air flow. Outside air enters through an intake grille in cowl. Heater is controlled by the outside-air door, shut-off door, and defroster door—all positioned by vacuum servo units. Mounted on driver's right, five heater-control buttons are labeled OFF, LO, HI, DEF and V.

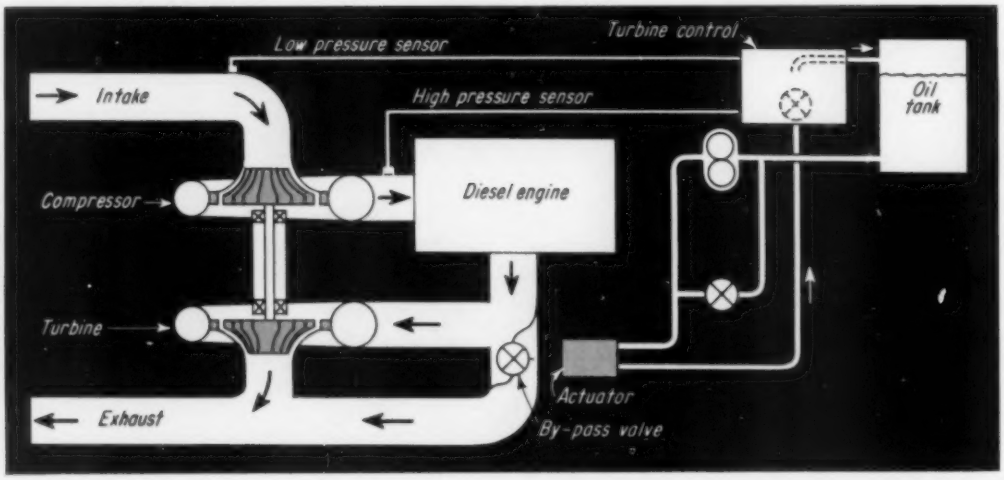
The OFF button stops the heater blower and closes the shut-off door to stop outside air from entering the heater. Pressing the LO or HI buttons opens shut-off door and raises defroster door to heat position, directing 80% of the air to floor of the car. Pressing the DEF button selects high blower speed, opens shut-off door and lowers defroster door to direct 60% of the air upward against the windshield. The V button shuts off the blower and opens outside-air door to direct incoming air toward passenger's feet. Temperature is controlled by a sliding lever connected to the water temperature-control valve.



SUPERCHARGER GIVES PEAK POWER at RIGHT TIME

This diesel-engined tractor responds fast under heavy load, thanks to efficient supercharging. Then control cuts in to hold turbocharger at peak power.

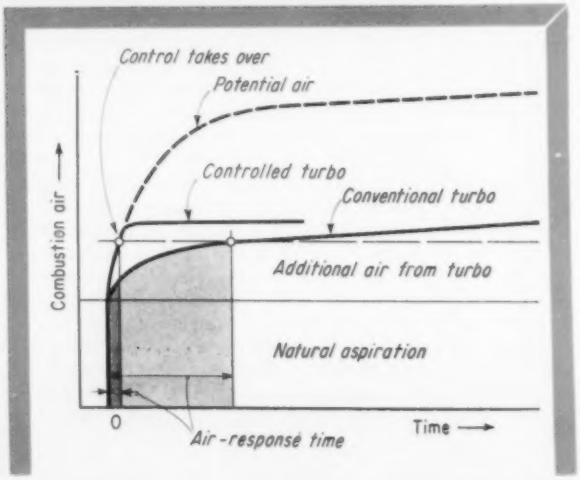
There is less telltale exhaust smoke at low speeds, indicating fast-peaking horsepower and greater lugging ability. Another result: such Caterpillar wheel tractors, DW20 and DW21, can operate at higher speeds with decreased specific fuel consumption. The controlled supercharging system is produced by Garrett Corp, AiResearch Industrial Div, Los Angeles, and may be applied to any turbocharged diesel.

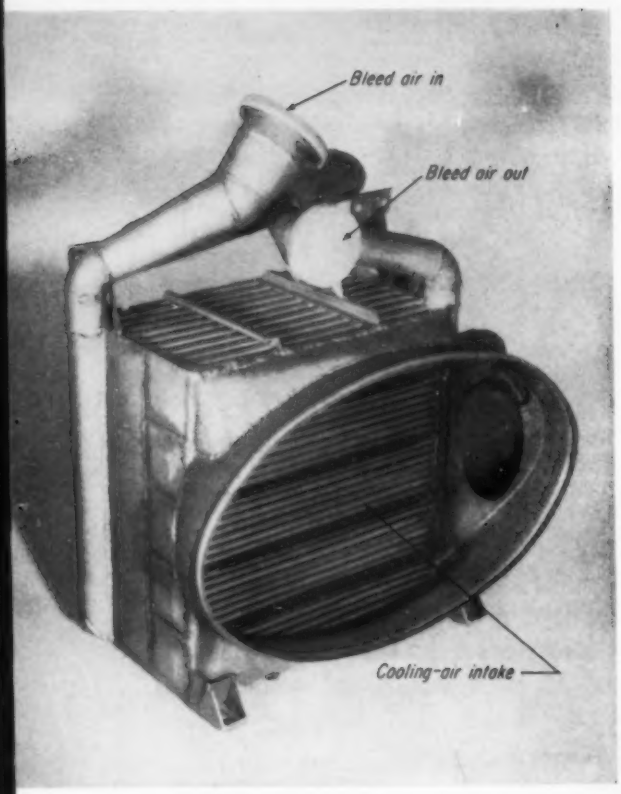


Flow of exhaust gas . . .

through turbine is controlled in this design to maintain efficient turbo speed. This contrasts with limitations of supercharged engines using free-floating turbochargers: low operating speed gives insufficient compressed air for needed engine torque; high speed is restricted either by turbo speed limit or engine pressure stress.

The controlled system matches turbocharger to the engine: turbine nozzle is big enough to give adequate supercharging at lower engine speeds. As engine accelerates, the turbocharger speeds up too—until compressor supplies enough air for efficient engine operation. When compressor speed and supercharger boost reach optimum, actuator cuts in bypass valve—now turbine receives only enough exhaust gas to maintain proper air compression.

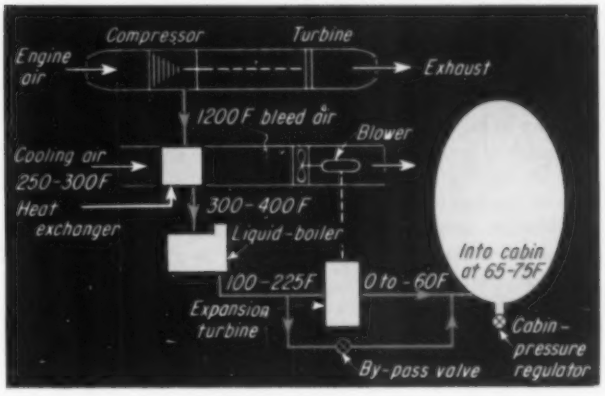




PAPER-THIN STAINLESS Improves HEAT EXCHANGER

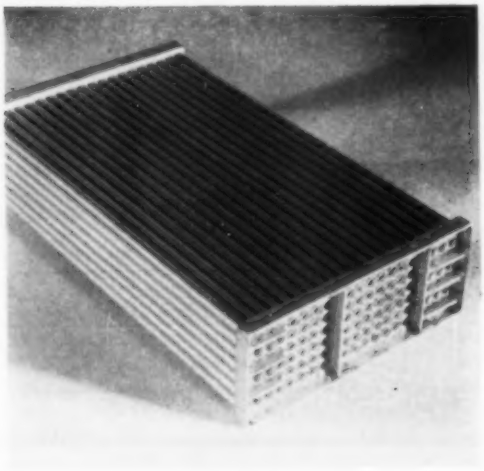
Jet passengers get pressurized air conditioning from 1200-F engine-air cooled to 65-75F. Key component in cooling circuit is high-volume, lightweight exchanger of multipass design.

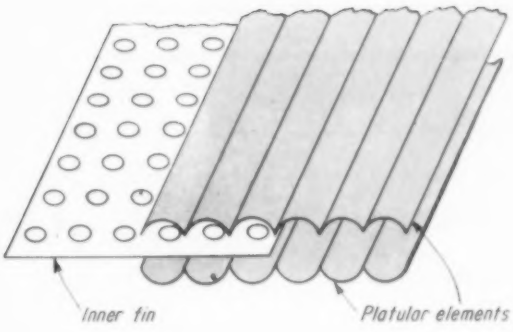
Heat exchanger, photo at left, drops temperature 900°. Rest of assembly includes liquid boiler, expansion turbine, bypass valve and pressure regulator. Produced by Janitrol Aircraft-Automotive Div of Surface Combustion Corp, Columbus, Ohio.



Air-conditioning circuit . . .

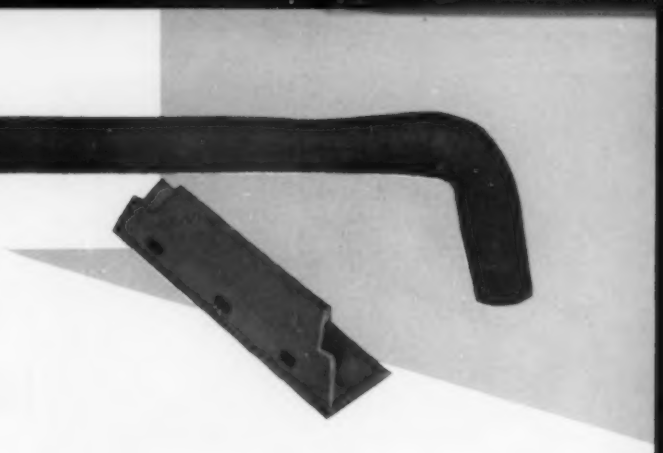
begins with engine air bled off at 1200 F from compressor section ahead of gas turbine. It goes through 7-module heat exchanger that removes 180,000 btu/hr at approximately 90% efficiency, then through liquid boiler for further cooling by evaporation. Next step is through expansion turbine (which also powers the exchanger blower) that brings the air down to as low as −60 F. Bypass valve permits mixing to control final temperature of pressurized air entering cabin.





Heat-exchanger tubes . . .

are of platular construction. Stainless steel 0.0035 in. thick is shaped, assembled and brazed to produce multitube plate. Inner fin with stamped bosses may be included to give turbulent flow that improves heat transfer. Bundles of plate-tubes are positioned in end housings —swaged and brazed to form modules. Platular construction gives strength needed to resist high-pressure air flow required by jet aircraft.



Slip casting made these . . .
metal-ceramic parts, too large or intricate for other shaping methods: (this page) closed tube with bend, flame-holder segment; (facing page) 2½-in. OD pipe, jet nozzle.

SLIP CASTING...

From giving intricate shapes to clay, this slurry method moved into metal ceramics and now has made a start with powdered metal. Here's how it stacks up against other powder processes—and where it's heading.

L M SCHIFFERLI JR.
Staff Development Engineer, Haynes Stellite Co

The time-tried method of shaping parts known as slip casting is widening its field of usefulness. This is a technique long used with clays and more recently applied to metal ceramics. It has now evolved into a new way to cast parts from powdered metals.

Here, as in powder casting methods, the starting point is a solid ground into a fine powder. But turning this powder into a slurry before casting, rather than dry-pressing it into a compact makes a difference. The process allows larger parts and more intricate ones—with smooth curves, and with undercuts in the right places. There is also more uniform and higher strength because of the finer grain size.

Design data given here comes from working with metal ceramics such as chromium-aluminum oxide, and with a limited amount of tungsten metal which, because of its high melting point, can be shaped only by powder methods. Tungsten has therefore become the first metal powder to be slip-cast commercially—as applied to metals, the method is still in its infancy. There are several reasons why its applications are expected to grow:

- As binders improve, the casting material shows higher strength in its green state (before oven drying).
- Adaptation to lighter metals such as stainless steel (already developmental: *PE—May 19, p 12*) and titanium will allow larger parts than can be had with heavy tungsten, and closer dimensional tolerances.
- The intricate shapes possible with slip casting indicate this method will compete with investment casting of parts.
- As with all powder-metal methods, it can combine materials that would otherwise segregate—indicating its chances of augmenting many of today's more conventional production processes.

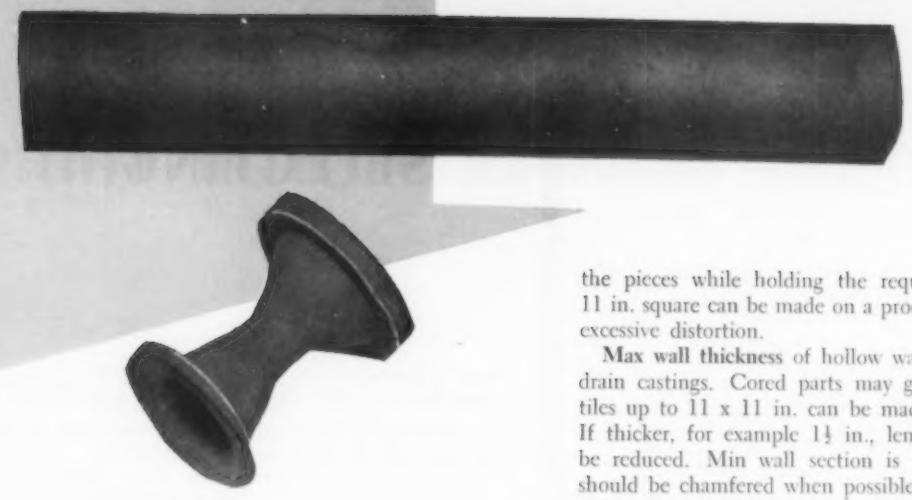
Solving Slip Problems

The process is basically no different for metal ceramics and metals than for clays. The powder is dispersed into a liquid suspension called the slip. This mixture is poured into a plaster mold, which absorbs the liquid and de-

COMPARISON OF POWDER FORMING METHODS

	Slip Casting	Cold Pressing	Hot Pressing	Extrusion*
Shape of part	Intricate shapes with undercuts	Straight sides, Fine surface detail	Straight sides	Wide choice of cross-section
Size of part	Large, limited by green strength Min wall, 1/16 in.	Max—dia, 10.; length to dia, 8:1 Min wall, 1/32 in.	Limited by press size	Continuous Section limited by press size
Mold or Die Material	Plaster	Steel Tungsten Carbide	Graphite	Abrasion-resistant steel
Mold or Die Life, No. of parts	80 to 100	Steel—25,000 Tungsten Carbide—over 1 million	Usually 1	Limited by die wear
Production Rate	Low	High	Moderate	High
Dimensional Tolerance, in./in	±0.030	±0.0015 radial ±0.0025 axial	±0.005	Slightly better than with slip casting

* Data is for ceramics; process not presently used for metals



...ITS FIELD BROADENS

posits the solids on surfaces of the mold. For a hollow casting, the slip is poured out of the mold after the desired thickness of solids has formed. Then the casting is allowed to dry and shrink in the mold. This gives a green casting, to be oven-dried and sintered like metal-powder compacts.

But to adapt this process for metal powder wasn't simple. Clay forms a silicious gel and binds ceramic greenware with natural strength; a metal powder does not. Its strength in the green state is low. This is why a slip-cast part made from a heavy metal like tungsten cannot be too large—it would not be able to withstand its own weight during sintering.

Preparation of the slip is further complicated by the need for a correctly determined setting time. It should be fast enough for a profitable production pace, while slow enough to benefit from these advantages of slower setting: more-complex shapes with varying cross-section; smoother surfaces free of pouring marks; greater shrinkage, which facilitates removal from the mold. But this shrinkage itself needs watching. It induces stresses, especially in complex parts—the green casting will tear before the rigid mold gives. Other requirements of a good slip: It should give castings with low porosity so there will be high density and high strength; and with low firing shrinkage so sintered dimensions will be accurate.

Tips in Design

Length of parts is limited by length of the furnace and cross-section of the pieces. For example: tubes from ¾ to 3½ in. dia can be made 42 in. long (the present max furnace size) while rods ¼ in. dia are limited to 24 in. Tubes can be made longer than the furnace if threaded together or, where service permits, brazed to other parts.

Max width is limited by methods that will support the pieces while holding the required flatness. Pieces 11 in. square can be made on a production basis without excessive distortion.

Max wall thickness of hollow ware is about ¼ in. for drain castings. Cored parts may go up to ½ in. Solid tiles up to 11 x 11 in. can be made up to ¾ in. thick. If thicker, for example 1½ in., length and width must be reduced. Min wall section is ⅛ in. and all edges should be chamfered when possible to prevent chipping during handling. Changes in section should be gradual, with pronounced radii. Fillets and radii should be as large as permissible and no smaller than ⅛ in.

Dimensional tolerances on most parts can be held to ±3%. Closer tolerances must be machined or ground into the finished part.

Holes may be drilled into the part or cored into the casting. But in coring, the slip shrinks around the core, making retraction difficult without help from a draft. So cored holes should allow for draft and have walls heavy enough to withstand retraction of core pins. Slush casting will give holes or hollows more easily, but with wider dimensional variation.

Flat surfaces on a part help support it during sintering. Although rounds and V-shapes can be supported they are more difficult to hold true.

Other Powder Techniques

Cold pressing is more economical but only for large quantities of small, simple parts. Furthermore, cold pressing needs steel dies and heavy presses. For example, a 10 x 10-in. tile will require a 1000-ton press to compact it—at the pressure of 10 tons per sq in. normal for most powder parts. This is a size that could easily be slip cast.

Hot pressing successfully applied to certain refractory materials has these disadvantages: The hot graphite mold reacts with some metals and is usually used only once.

Extrusion, another method of preparing shapes from powders, mixes the powder with an organic binder for plasticity and extrudes the resulting plastic mass through steel dies. The lengths are cut off as needed, then sintered. But here, too, steel dies are needed and the process limits the shapes to a constant cross-section.

EDITOR'S NOTE: For more on making metal-powder parts and small intricate shapes:

"Design for Metal-powder Parts,' Aug '57, p 183, gives basics on design intended specifically for the cold-pressed process.

"Titanium Carbide," Nov 11 '57, p 84, covers powdered-metal techniques utilizing combined advantages of titanium carbide and stainless steel to solve high-temperature problems.

"Submicron Metal Powders," June '57, p 182, discusses fine particle-size that makes sintered parts as strong and dense as solid metal; and "Powdered Glass Gives Mold for Stronger Castings," Oct 14 '57, p 68, discusses investment castings in terms of ceramic shells that give fine grain.

"Design for Investment Casting," Apr '56, p 166, gives advantages and limitations of this method; and alloys available.

HERE'S HELP IN SELECTING THE

Want to pinpoint the right type of ac or dc motor for any job? The answer is at your hand.

In these last few years, *Product Engineering* has covered the field with several dozen articles on motors and controls. They span the power range from 1/2000 hp to 4000 hp. Taken together, these articles tell about performance, cost, duty cycle and other vital statistics involved in the selection of the one best motor for a machine.

Here is your bibliography of the key articles.

FRANKLIN D YEAPLE, Jr, *Associate Editor*

Motor speed, an important consideration dictated by load requirements, is the basis for the arrangement of titles given here.

The first heading, *Single-speed*, covers ac motors that run at essentially constant speed . . . control of load speed is not their primary function. The second grouping, *Variable-speed*, describes motors that operate at varying or adjustable speeds determined by the control. The last section, *Special Types*, covers design for non-standard applications, including servos and actuators.

SINGLE SPEED

Performance factors for constant-speed motors, as compared with dc and variable speed, are tabulated in two digests in annual issues. "A Guide to Motor Application," Mid-Sept. '58, p H2, provides shortcut to motor selection with 2-page table of single-phase, polyphase and dc motors–and job recommendations; "How to Select Electric Motors and Motor Controls," Mid-Oct '52, p H2, compares performance and costs for all single-speed and variable-speed motor types from sub-fractional to 50 hp.

Four logical ways to make sure that the smallest and least expensive is chosen are outlined in "How Big a Motor," Sept '52, p 142.

Load calculations are made easier with these two nomographs: "Torque, Rpm, Hp," June 9 '58, p 83, for straight linear conversion between force, speed and power units; and "Selecting Motors for Fans and Centrifugal Pumps," May '56, p 217, for applications where torque varies as the square of the speed. Moment of inertia is derived, and its conversion from load to motor speed given in "The Significance of WK^2 and How to Calculate It," Mid-Oct '53, p H24.

NEMA standards for rating and frame size are interpreted in: "NEMA-Rerate Motors," Nov '55, p 195, from 1-30 hp; and "New NEMA Standards for Motors," Feb 3 '58, p 54, from 40 to 125 hp. Locked-rotor current limits are given in "Starting Current–NEMA Limits," Apr 28 '58, p 107.

Protection against mechanical and electrical damage is given by bi-metal, magnetic or melting-alloy relays–see "Overload Relays for Motor Protection," Mid-Oct '54, p H2.

Single-phase

Characteristics of small single-phase motors, as compared with polyphase, synchronous and dc types in the range from 1/300 to ¾ hp are summarized in "Selection Guide for Small Motors," Mid-Oct '53, p H10. Speed-torque curves and winding diagrams for 11 types of fractional and subfractional motors are diagrammed in "Fractional Hp Motors," Mid-Oct '57, p H18. Squirrel-cage single-phase motors for ½ hp and less are described in "Shaded-pole Motors," July '57, p 169.

Increased use of squirrel-cage, single-phase motors in business-machine applications is discussed in "Small Induction Motors," Mar 3 '58, p 72.

Domestic-type motors and planning prior to selection are detailed in "Applying Single-phase Capacitor-start Motors," Oct '56, p 196.

Matching motor to fan characteristics is the technique developed in "Motors for Direct-connected Fans," May '56, p 194.

Polyphase

Calculations of duty cycle are given in: "Determination of Motor Hp from Duty Cycle," in two parts—Aug '50, p 131, and Sept '50, p 135; and "Importance of Duty Cycle in Selecting Polyphase Motors," Nov '54, p 176. For selection of type if duty cycle is known, see

tables in "Selecting Polyphase Motors," Aug 18 '58, p 58. "Motors for Severe Duty Cycles," Jan '51, p 148, lists major types available in order of increasing cost.

Inertia and heating problems are solved in "Driving High-inertia Loads," Apr '56, p 142, which relates flywheel inertia to motor design; "Lower-speed Motors for High-performance Drives," Sept 16 '57, p 96, shows how a lower base speed is as important as decreased inertia in reducing energy losses during starting or stopping; "Controlling Temperature Rise in Induction Motor Drives," Jan '57, p 167, tells how to improve squirrel-cage motor life by good matching to duty cycle.

Starting-up and running problems with polyphase motors are discussed in two articles: "Methods for Starting 3-phase Motors," Feb '56, p 183, describes all methods, with precautions given for excessive voltage and current variations; "Operating 3-phase Motors from Single-phase Supply," Apr '55, p 134, shows how temporary lack of 3-phase supply at proposed installation need not prevent ordering of polyphase motors.

Protection from environment is also important: "How to Select Motor Enclosures for Contaminated Atmospheres," Oct 14 '57, p 106, includes tables of unusual ambient conditions, with suggested enclosure types; and "Motors for Hazardous Locations," July '53, p 148, defines explosion hazards, describes typical safeguarded motor designs.

VARIABLE-SPEED DRIVES

Dc motors and controls provide one straightforward solution to infinitely variable speed. "Types and uses of Dc Motors and Controllers," Mid-Oct '56, p H14, shows winding design, control methods, and performance for all dc motor types; "NEMA Standards for Dc Motors and Generators," Mid-Oct '56, p H10, defines dc motors and evaluates speed control, temperature rise, and load inertia; "Improved Dc Motors," Mar 31 '58, p 108, describes new water-cooled, shell-type field-and-armature controlled motors that are more compact; and "Safety in Dc Motor Controls," Dec '55, p 193, shows how to prevent overheating, fire and injury.

Ac motors and controls can have variable or adjustable speed, but usually need frequency-conversion equipment or special windings to do the job. For a drive requiring several fixed speeds see the following two articles: "Multispeed Motors," Jun '57, p 140, and "Controls for Multispeed Motors," Feb '57, p 183.

Packaged variable-speed drives employing vacuum-tube controls, eddy-current clutches, motor-generator sets and amplidyne motor drives are compared for performance in "How Adjustable-speed Electronic Drives Compare," Nov '52, p 189. "Power Control Circuits and Their Components," Mid-Oct '55, p H17, gives circuits and ratings of typical, commercially available controls for ac and dc equipment.

Keeping several motors in step as machine speed is varied is discussed in "Adjustable Frequency Multi-motor Drives," May '52, p 146. See also "Reluctance Motors for Adjustable-frequency Drives," Mid-Oct '57, p H22, for description of a compact low-cost motor.

Fast speed changes are made possible by instantaneous controlled overvoltage method described in "Forced-torque Electric Adjustable-speed Drives," Apr '54, p 168.

SPECIAL TYPES

Unusual environments can be met by canned motors with hermetically sealed stator and fluid-piston rotor bearings described in "Hermetically Sealed Pump-motor Unit Will Handle Any Fluid," Jun '53, p 216. A motor with completely open construction can operate with bearings and windings immersed in the fluid, "Immersed Motors," Sept 15 '58, p 80.

Winding variations and special rotor design can give almost any desired characteristic to a motor: "Spherical-type Variable Speed Motor," July 7 '58, p 68, evaluates English-made skewable-stator ac induction motor; "Dynamic Braking of Squirrel-cage Motors," Aug '53, p 178, describes winding techniques that allow motors to be braked electrically; and "Characteristics of Electric Motor Braking," Mid-Oct '57, p H2, has handy table of all electrical and mechanical braking methods, with clear descriptions of how they work.

Space and mechanical requirements dictate many different configurations: "Shaftless Ac Motors," June 9 '58, p 56, describes shell-type motor made with bored-out rotor to fit over machine drive shaft; "Axial-airgap Motors for Machine Tool Drives," Sept '55, p 129, shows motor made shorter but with increased diameter; and "Electric Motors for Portable Tools," June '55, p 156, shows how series motor packs more power by turning at high speed.

Servo and actuator motors for automatic control are evaluated in "Torque Motors and Brakes," Apr '57, p 146, which gives construction, performance and applications for high-slip squirrel-cage induction motors. "Rotating Components for Automatic Control," Nov '53, p 147, gives details on all types ac and dc servos, torque motors and other special control components; and "When to Choose a Non-clutch Drive," Apr '57, p 194, includes a chart showing where motors can replace clutches for jobs such as inching, actuating, tensioning, cycling, braking and free-wheeling.

cheap, quick . . .

NAME PLATES for PROTOTYPES

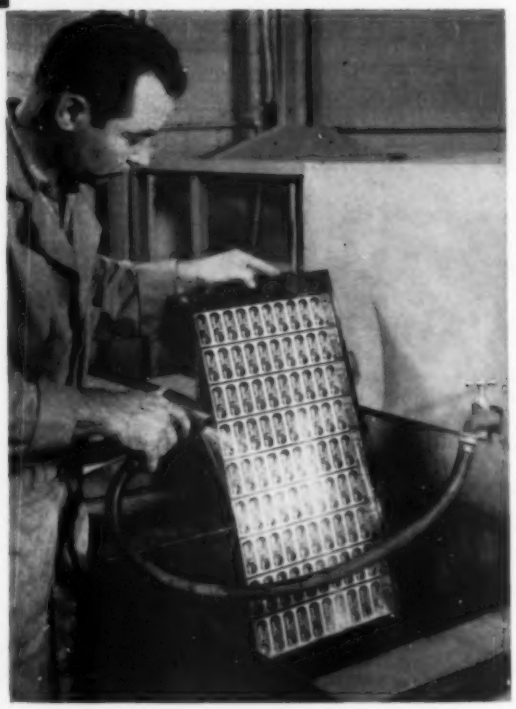
1 Composite negative . . .
is used to expose the sensitized acid-resistant coating on a colored sheet of anodized foil.

W R MacKINNON, Chief Process Engineer
Hughes Aircraft Co, El Segundo, Calif.

When only one or a handful of name plates, dials or instruction panels are needed, usual methods take too much time and money. Design changes in a prototype can obsolete a name plate before it is finished; tool and set-up charges are costly. A fast low-cost method was needed to produce finished name plates in short runs.

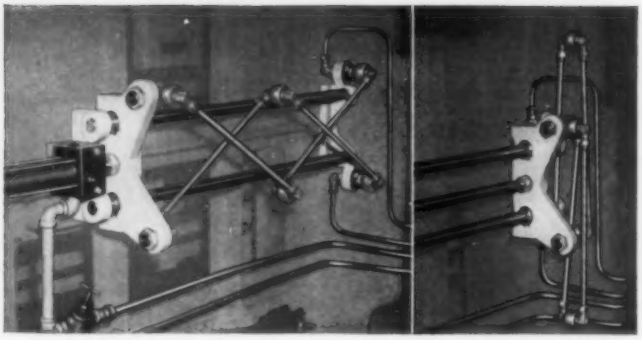
The process engineering department at Hughes found the answer with Fotofoil, an anodized colored metal sheet coated with a light-sensitive acid-resistant ink. Sensitized sheets are supplied by Miller Dial and Name Plate Co, El Monte, Calif.

Art work is prepared and photographed, and the negative used to make a print on sensitized aluminum sheet of the desired thickness. The sheets are developed and etched to produce finished name plates in a matter of hours. Moderate quantities can be produced economically, and two workers with modest equipment in a 6 x 8-ft area can produce 7000 parts per day.



2 Exposed sheet . . .
is developed by a process that softens unexposed areas so they can be washed off by a stream of cold water. A 1-min. acid dip then removes colored anodic coating, exposing white metal.

3 Developed sheet . . .
is then sheared and punched to produce finished name plates.



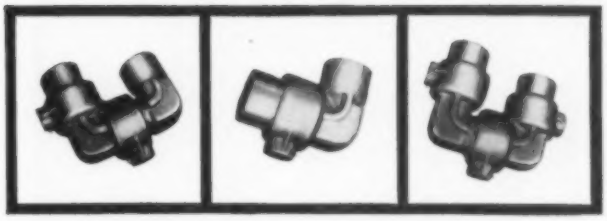
Chiksan Swivel joints, with full 360° rotation allow duplicate sets of lines (left) to be compacted into small spaces (right).

PROBLEM: EXTREME BEND RADII

SOLUTION: **CHIKSAN SWIVEL JOINTS**

Got a bend radii problem? Then let Chiksan engineers go to work on the answer. Chiksan has the years of experience and know-how to handle your problem quickly, efficiently.

Chiksan Swivel Joints provide unlimited flexibility in a compact package to meet your exacting pressure and temperature requirements. Be it for air, hydraulics, fuel, oil, water or other fluids, it will pay you to have Chiksan provide the right swivel joint for *your* bend radii problem.



Typical Chiksan Swivel Joints

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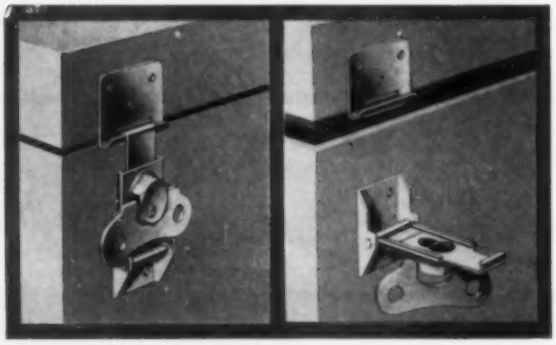
A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

CHIKSAN COMPANY — BREA, CALIFORNIA • CHICAGO 3, ILLINOIS • NEWARK 2, NEW JERSEY

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Chiksan of Canada, Ltd., Edmonton, Alta.

Zero cases, sealed pressure-tight by **LINK-LOCK**,

Simmons No. 3 LINK-LOCK fasteners are employed on these deep-drawn aluminum Zero transit cases. LINK-LOCK is available in three sizes, for light, medium, and heavy duty.



No. 2 LINK-LOCK. Half turn applies high closing pressure, counter-turn disengages for opening.

guard instruments against humidity, dust, atmospheric pressure changes

Delicate electronic and optical equipment is shipped long distances . . . handled again and again . . . and sometimes stored for long periods in transit cases manufactured by the Zero Manufacturing Company, Burbank, California.

The unique containers shown here are deep-drawn aluminum, seamless, with precision-fitting gasketed lids. They comply with rigid military specifications, insuring protection of contents against humidity, dust, and variations in pressure.

To effect the critically important pressure-tight seal, Zero specifies Simmons LINK-LOCK fasteners.

Here's why LINK-LOCK is ideal for use on precision-built military cases as well as on inexpensive commercial containers:

- Positive-locking without springs.
- Impact and drop resistant; not affected by arctic temperatures.
- Compact design—lies flat open or secured.
- Latch design can be varied to suit different applications.
- High preloading and high load-carrying capacity.

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It contains specifications, drawings, details of LINK-LOCK and other Simmons Fasteners with unlimited money-saving applications.

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See our 8-page catalog in Sweet's Product Design File

Unit-mounted frame and coil part . . .

with hardware assembly kits . . .

and "universal" contact blocks . . .

permits assembly of more than 100 devices

GENERAL ELECTRIC ANNOUNCES

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General Electric's new line of d-c contactors and relays features a new concept in component design—building-block construction. Using front-connected frame and coil parts, standard assembly kits, and "universal" contact blocks, more than 100 different control devices can be assembled. This new design concept makes possible these important cost-saving advantages:

Reduced inventory—with building-block design, you need to stock only a minimum number of standard parts. Not only does this mean less costly inventory, but valuable storage space can be released!

Immediate availibility—with General Electric devices, the contactor or relay you want can be assembled on the spot! No need to order a specific device and await delivery, or stock a large number of special ratings. Assemble what you want—when you want it!

Order today from General Electric's complete line of stock d-c contactors and relays featuring the new building-block construction.

NEED OTHER COMPONENTS?

General Electric also has complete lines of plate rheostats and vitreous-enameled resistors for all your control needs. For more information, contact your General Electric Sales Representative or mail this coupon today! Industry Control Dept., Roanoke, Va.

GENERAL ELECTRIC

Vitreous-enameled resistors—1070 ohmic values from stock, fixed or slide-wire, 5 to 200 watts. Call your G-E representative.

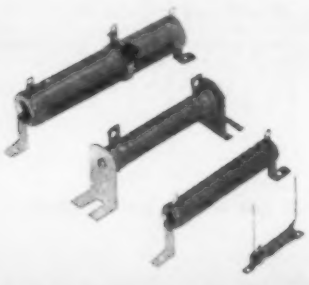

Plate-type rheostats—windings are completely encased in metal to give longer and more reliable service for any application.

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General Electric Co.
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Please send the following bulletins:

- ☐ GEA-6621—D-c contactors and relays
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- ☐ GEA-6474—Plate-type field rheostats

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NEW *Quick-Reset, High Speed* *Geared* REVOLUTION COUNTER

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Height — 2 13/16"

Here's a new geared revolution counter designed for general purpose work where high speed and quick reset geared revolution counters are required. It will accept speeds up to 6000 rpm or 8000 cpm.

One flick of the lever (through 60° arc) will reset the counter to all zeros. A new modern case design and extra big numbers (.227 in. high) provide excellent visibility at extremely wide angles. The counter is ideal for in-line reading.

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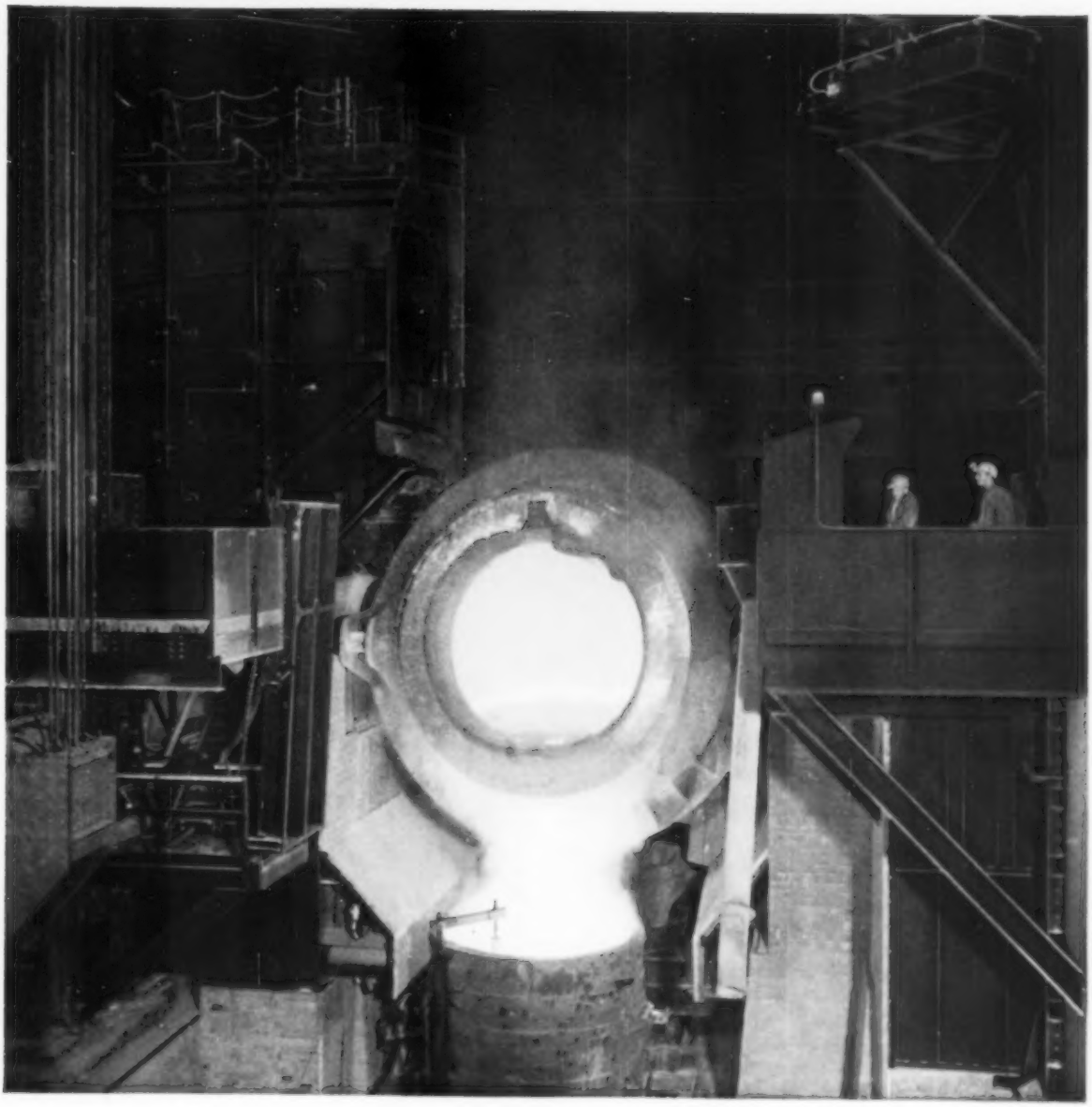
CIRCLE 149 READER SERVICE CARD

CIRCLE 150 READER SERVICE CARD→



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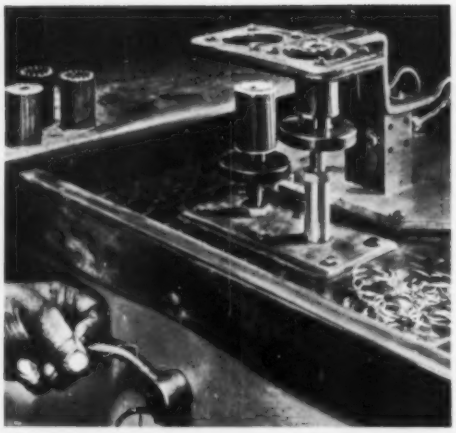
The vessel shown above produces 90 ton heats of Oxygen Steel. Two of these vessels—the largest producing in the world—have been added to the original Oxygen Steel making equipment and are a vital part of the expansion program at McLouth's Trenton, Michigan plant.

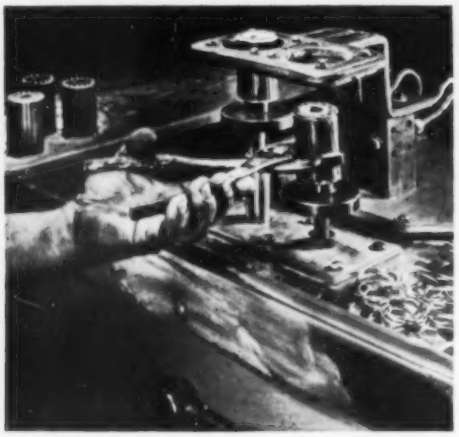
Ever since McLouth pioneered the first Oxygen Steel Process in the United States, we have continued to expand and improve our manufacturing facilities to bring you better steels for the product you make today . . . and the product you plan for tomorrow.

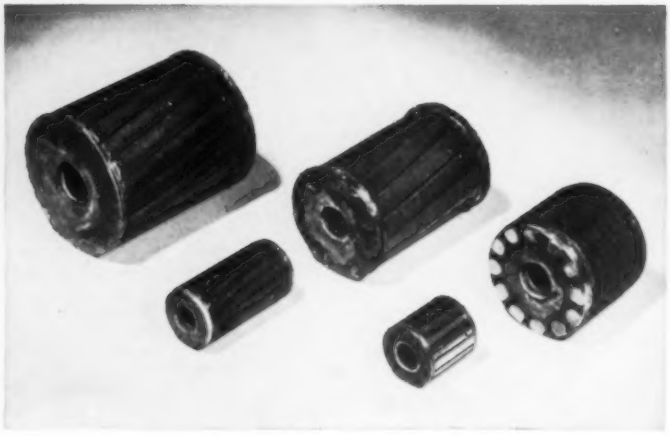
McLOUTH STEEL CORPORATION Detroit 17, Michigan

Manufacturers of high quality stainless and carbon steels.



Handy & Harman Sil-Fos Silver Brazing is Used by Induction Motors Corp. in 5427 Different Motors





FIRST, BULLETIN 20

This informative booklet will get you off to a good start on the values, techniques and economies of low-temperature silver brazing. A copy awaits your request.

Induction Motors Corp. of Westbury, New York, and Maywood, California, has built an outstanding reputation as a designer and manufacturer of sub-fractional horsepower motors...for 5427 high performance reasons.

This large variety of motors, blowers and fans for an equally large variety of applications, stems from 15 basic motor frame sizes, depending on length, pole materials, windings, groove angles and the like.

Handy & Harman silver alloy brazing is concerned with brazing the rotors. Each rotor (whatever the size) is joined by a preformed ring of Handy & Harman SIL-FOS, by induction heating – at an alloy cost that is reckoned in pennies. For example, the alloy cost per 7/8" frame is two cents per joint, or four cents per complete assembly.

That's an example of the economics of silver alloy brazing. Performance requirements are quite another thing – and they are unquestionably stringent. Many of these motors are used in aircraft and missile work and must, of course, meet the most extreme environmental conditions.

Strength alone would be reason enough to discuss the merits of silver alloy brazing . . . and to point out as a reason for its wide acceptance throughout industry. The facts are that there are many more benefits; gas- and leak-tightness, thermal and electrical conductivity, ductility, and production economy – are all *joint qualities* of silver alloy brazing. At any time, we will be happy to discuss any or all of these qualities (and others), as applied to your product or production method. The benefits are large and you can enjoy them.

Your No. 1 SOURCE OF SUPPLY AND AUTHORITY ON BRAZING ALLOYS

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General Offices:
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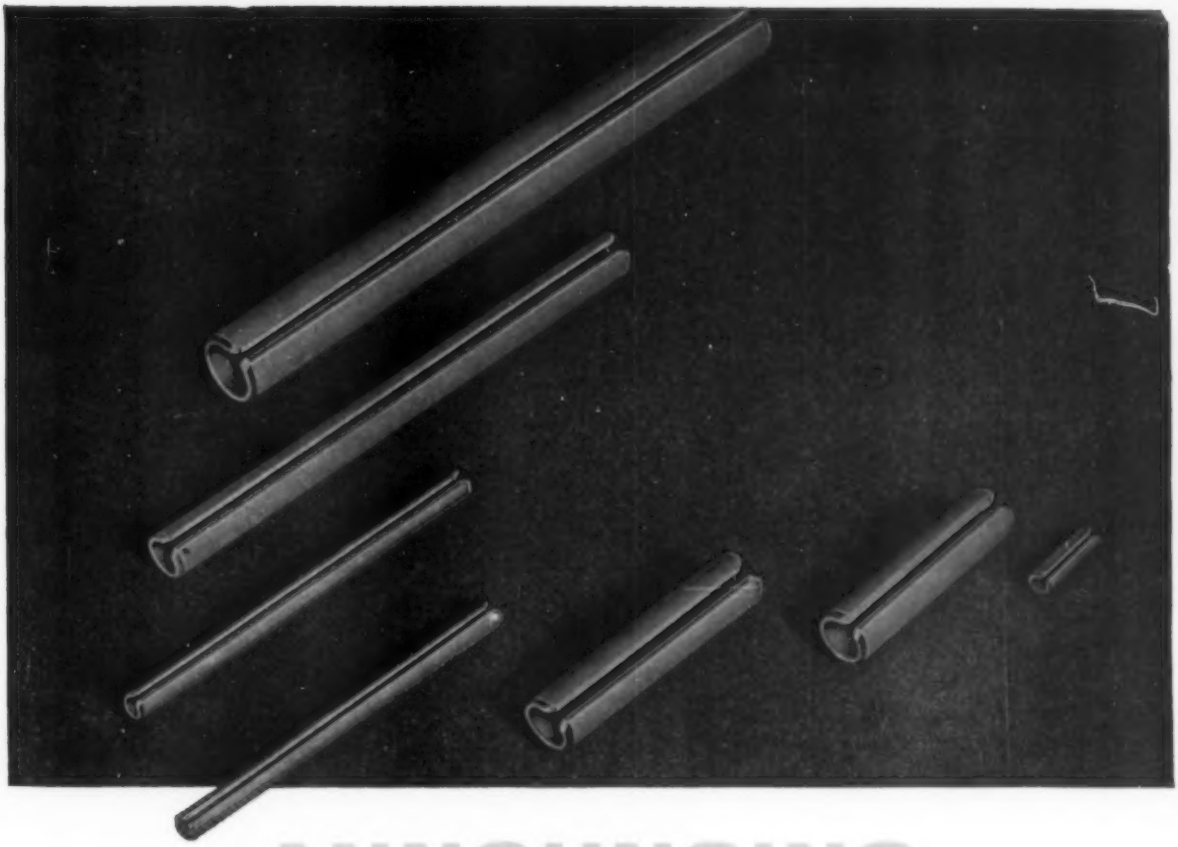
Offices and Plants: Atlanta, Georgia • Bridgeport, Connecticut • Chicago, Illinois • Cleveland, Ohio • Detroit, Michigan • El Monte (Los Angeles), California Oakland, California • Providence, Rhode Island • Toronto, Canada • Montreal, Canada



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the Beryllium Copper ROLLPIN®

Strong . . . highly resistant to corrosion . . . nonmagnetic . . . extremely conductive

Now you can use Rollpin to cut assembly and maintenance costs in a whole new group of applications. A new line made of beryllium copper, one of the strongest of the copper base alloys, opens the door to a wide variety of uses where resistance to corrosive attack, good electrical properties and other unusual characteristics are required. These slotted tubular copper spring-pins can be used in assemblies that range from plumbing fixtures to electrical instruments, particularly in conjunction with other copper base alloy components.

Rollpin has already established its ability to replace taper pins, straight pins and set screws; to serve as a rivet, dowel, hinge pin, cotter pin or stop pin . . . eliminating special machining, tapping and the need for hole reaming or precision tolerances. Driven into a hole drilled to normal production standards, it locks securely in place, yet can be readily drifted out and reused whenever necessary.

Rollpin is available in beryllium copper from .062″-diameter to .250″-diameter, and in steel and stainless steel up to .500″-diameter.

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Please send me the following free fastening information:

☐ Data on beryllium copper Rollpin

☐ Here is a drawing of our product. What self-locking fastener would you suggest?

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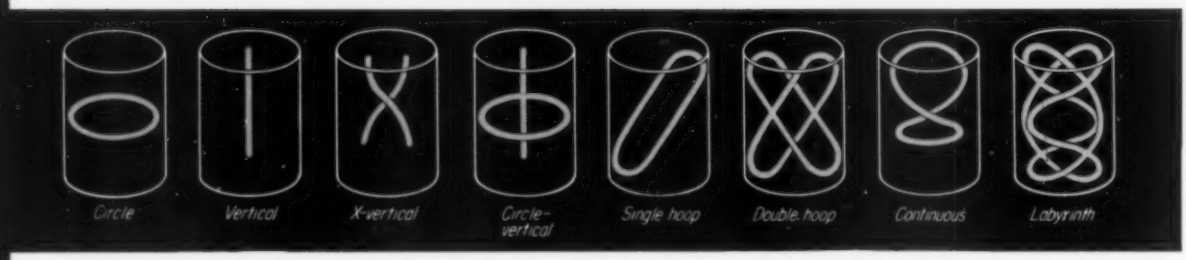
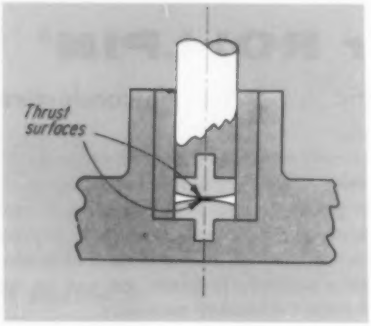
14 SPECIAL-PURPOSE

. . . for round, revolving shafts

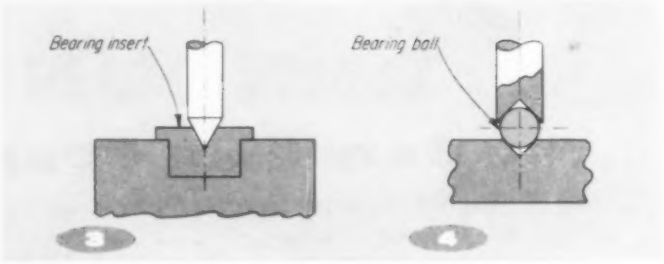
Here are linings, bearings and mounts illustrating a variety of helpful hints in bearing design.



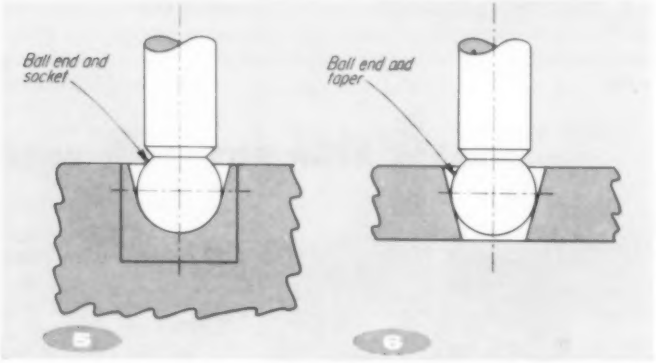
Groove patterns . . .
for bearing liners can be designed in almost limitless variations from eight basic arrangements shown here. Grooves help bring a copious supply of lubricant to reduce shaft friction. Such factors as speed, pressure and temperature affect choice of groove design.



Pedestal-type . . .
thrust bearing is usually designed to take thrust loads from shafts perpendicular to the bearing plane. As shown here, it is sometimes best to dome surfaces of bearing material to present minimum bearing area. This can speed up running-in time but bearing pressure is greatly increased. However, maximum permissible pressure varies greatly for different materials; it should not be exceeded.



Light-duty thrust . . .
bearings feature conical shaft-ends with no adjustment (3); screw-adjustment could be provided. Bearing insert (4) is often jewel or other low-friction material. Only line contact is given by ball between indented shaft and mount.

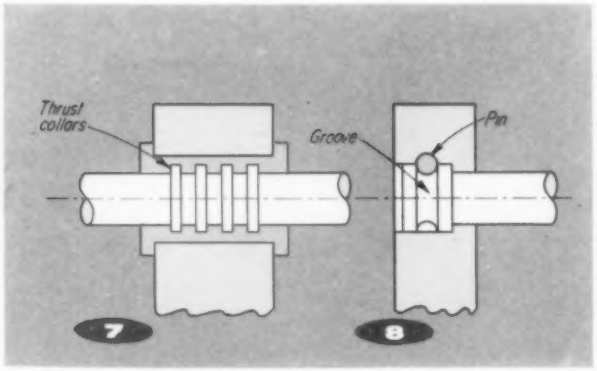


Universal bearings . . .
can accommodate thrust from any angle, subject to a practical maximum variation from vertical. Ball end on shaft accommodated by socket (5) is able to withstand heavier duty than when tapered hole (6) is bearing seat.

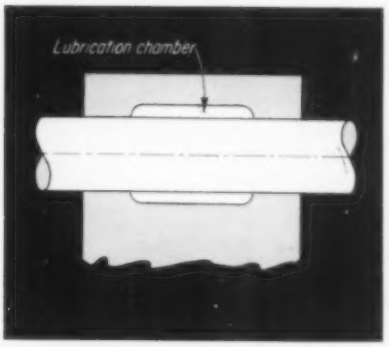
BEARINGS

Product Engineering

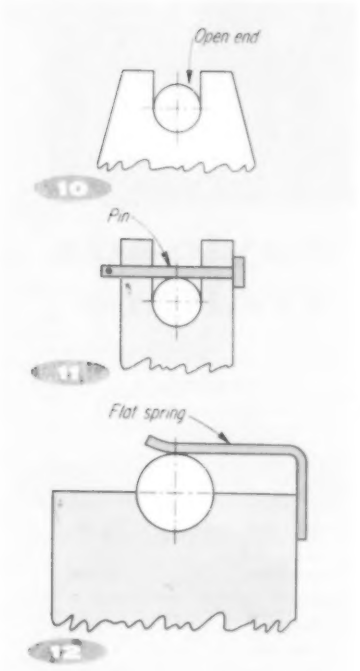
FEDERICO STRASSER, *Mankowitz & Strasser Ltd, Santiago, Chile*



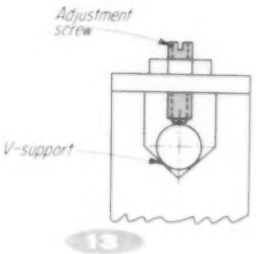
Journal and thrust . . .
bearing combined for large loads (7) consists of multiple thrust collars over which the loads are distributed. For light loads, however, simple design of pin and groove (8) is low-cost, efficient arrangement.



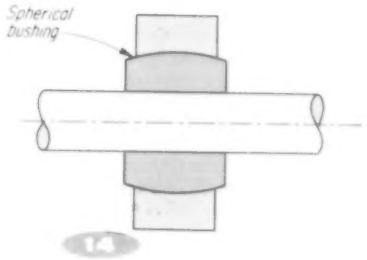
Chambered bearing . . .
can be extra long for best alignment and abundant lubrication.



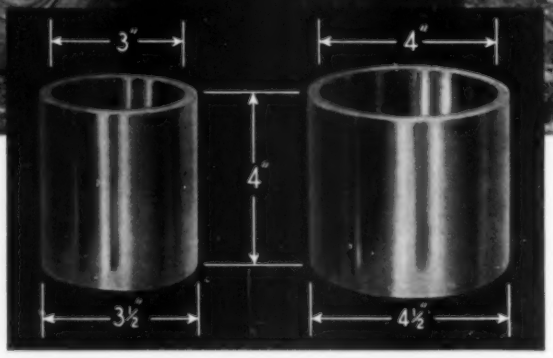
Open bearings . . .
provide shaft support only over half circumference. Such mounts are usually called for merely as intermediate supports when main bearings take most of the load. Completely open end (10) can be made more secure for shaft by including pin (11) or flat spring (12).



V-support . . .
with adjustment screw is only employed when shaft rotation will be occasional and slight.



Self-aligning . . .
bearing compensates for angular misalignment. Spherical bushing can either be left free to move at all times; or, once the shaft has been assembled and aligned, bushing can be locked with setscrew or other means.



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SELF-LUBRICATING

BEARINGS

prove a match for top payloads on ATHEY Rear Dump Trailers

Oilite* Bronze Bearings have proven more than a match for the 22 and 34-ton payloads on Athey Rear Dump Trailers.

Oil-cushioned against shocks and impacts, these Oilite heavy-duty bearings have demonstrated that they will withstand years of punishment and still give satisfactory service. They require only infrequent lubrication and help Athey substantially increase the dependability of its hauling units. Yet, Oilite Bearings *cost less* than many other type bearings!

No wonder more and more designers are specifying popular Oilite self-lubricating Bearings for motor vehicles, appliances, engines, power tools, machinery and countless other products.

Contact your local Oilite Engineer today. He'll gladly provide complete design information to help you make your bearing and bushing applications low-cost, dependable and maintenance-free. Look for him in your telephone directory under "Bearings—OILITE" or write direct to Dept. A-10.

TYPICAL PROPERTIES OF SELF-LUBRICATING BRONZE OILITE BEARINGS †	
Porosity, %	18-23
Ultimate Tensile Strength, (psi)	18,000
Compressive Strength (psi)	20,000
Elongation, % min. in 1"	10
Brinell Hardness	40

† Other materials and physical properties available.

* REGISTERED TRADEMARK
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the RIGHT FINISHES for STAINLESS STEEL

These tables cover electropolishing and other finishing methods in terms of applications and the appearance you want.

RICHARD E PARET, *Committee of Stainless Steel Producers, American Iron and Steel Institute*

MILL FINISHES . . .

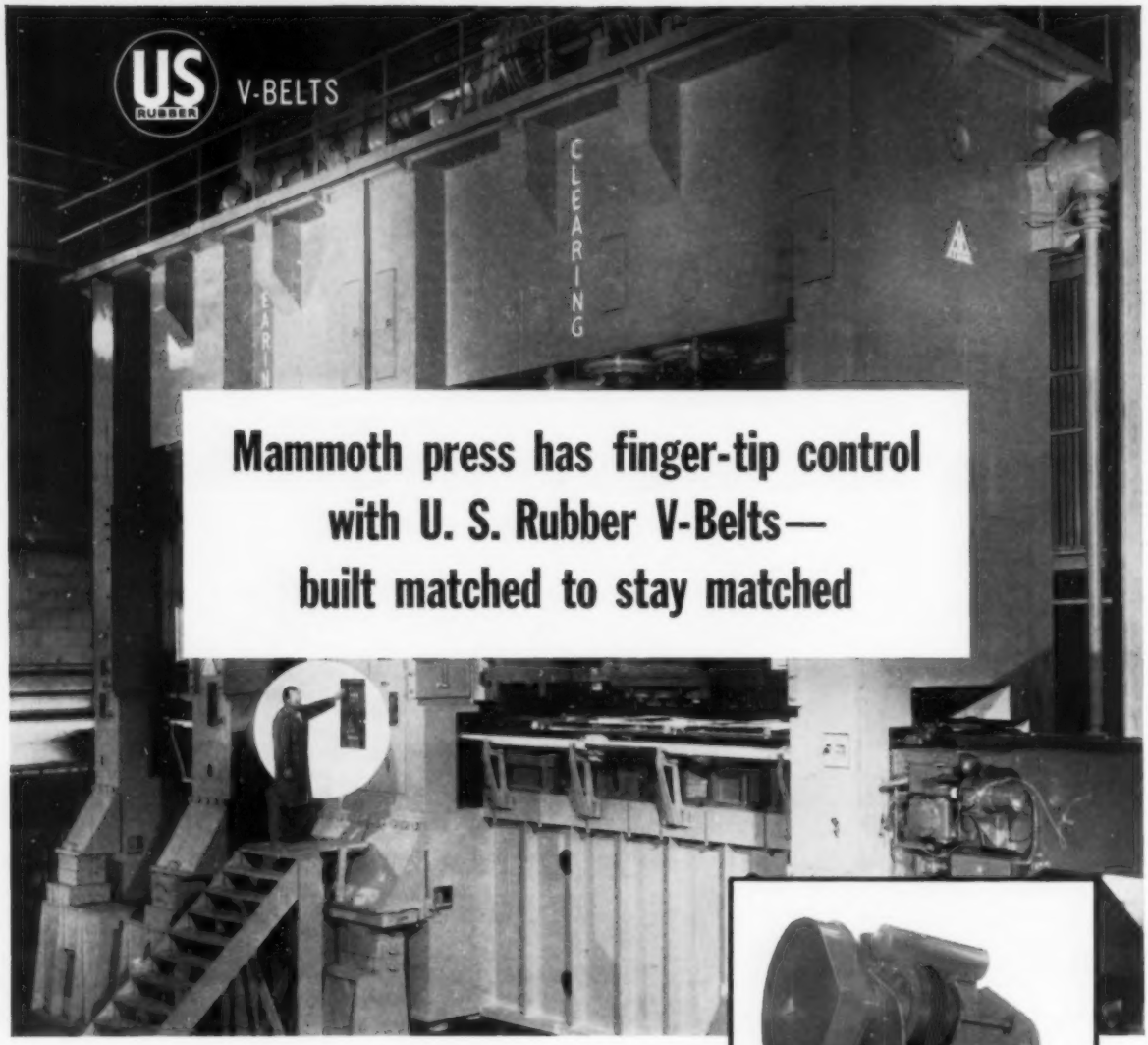
present a wide choice to designers

FINISH NO.	TYPE	SURFACE APPEARANCE	THESE ARE APPLICATIONS	
			Final Finish For	Preliminary Finish When
1	Hot-rolled, annealed & pickled	Frosty white	Hi-temp. conditions Industrial needs Other applications where appearance is not important	Surface will be damaged as in annealing
2D	Dull cold-rolled & pickled	Similar to #1 but brighter	Curtain walls Industrial applications	Severe drawing to be followed by polishing
2B	Bright cold-rolled	Bright, dense	Curtain walls Industrial, commercial & transportation equipment	Light forming to be followed by polishing
3	Intermediate polished	Bright, fairly good luster	A semifinished, polished surface is needed for subsequent finishing operations	
4	Polished	Bright, good luster; most commonly used polished finish	Architectural trim Restaurant kitchen & sanitary equipment	Where forming operations will not mar surface or can be blended easily. As base for #6, #7, and 8 finishes.
6	Tampico brushed	Soft, satiny	Decorative without high reflectivity	Follows finish #4
7	Polished	High luster	Decorative	
8	Polished	"Mirror-finish"	Decorative	

ELECTROPLATING BATHS . . .

give high-luster finish not achieved by mechanical means (but will not remove scratches or similar blemishes)

BATH	COMPOSITION	BATH TEMP., °F	CURRENT DENSITY AMP/SQ IN.	REMARKS
Phosphoric acid	4 parts—85% orthophosphoric acid 1 part—water with wetting agent	140–160	1–4 (2–12 v)	Removed metal remains in solution—ultimately requires replacement of bath
Glycolic acid—sulphuric acid	55% glycolic acid; 30% sulphuric acid; 15% water (by volume)	170–190	0.05–4.0 (4–9 v)	Removed metal settles out. Bath replenished with original solution plus conc. sulphuric acid
Citric acid—sulphuric acid	55–60% citric acid; 15–20% sulphuric acid; rest, water (by wt.)	180–200	0.05–4.0 (6–12 v)	Metal settles out. Replenish bath with equal portions of acids.



Mammoth press has finger-tip control with U. S. Rubber V-Belts— built matched to stay matched

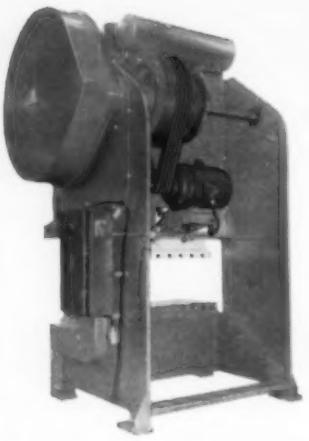
This triumph of press automation is believed to be the largest transfer feed press in the world. It was made by Clearing Machine Corp., Chicago, for General Electric's Home Laundry Department, Louisville, Kentucky. The press is 58' long, more than 42' high, and can produce tops for both G-E automatic washers and dryers without changing dies.

The tremendous shock loads transmitted by the press are controlled by 19-foot long U. S. Rubber V-Belts. Through a new method of construction, "U. S." belts of even this length—and longer—are produced to such close tolerances that there is no problem of matching belts for exacting response without lag or drag. That's one reason why these "U. S." belts stand up under the split-second movement of great forces . . . why they distribute the load to insure efficient pull with minimum stretch.

U. S. Rubber V-Belts are made in the world's largest and most modern plant devoted exclusively to the manufacture of endless belts.

• • •

When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.



Close-up of smaller steel forming press. Thanks to an exclusive method of manufacture, a set of U. S. Rubber V-Belts like these can be picked right from stock with the guarantee that they will *match perfectly*. No testing necessary.

Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

the RIGHT FINISHES for STAINLESS STEEL (cont)

HOW TO GET A NO. 4 FINISH . . .

no matter how rough the original surface

(Abrasive: aluminum oxide or silicon carbide—must be iron-free.)

OPERATION	GRIT[b]	WHEEL	LUBRICANT	SURFACE FT. PER MIN.	REMARKS
1 Grind[a] (rough)	20–60	Rubber or bakelite-bonded	Dry	5–6000	Starting operation for very rough weld beads
2 Grind (finish)	60–80	Rubber or bakelite-bonded	Dry	5–6000	Starting operation for heavy sheet or plate; hot-rolled finishes; light welds
3 Polish (rough)	80–100	Cloth	Polishing tallow or grease stick	7500	Starting operation for cold-rolled sheet or strip
4 Polish (finish)	120–150	Cloth	Polishing tallow or grease stick	7500	Similar to No. 4 mill finish

[a]Operation #1 is a preliminary required only for very rough work
[b]Number depends on quality of finish desired or grit used in prior operation—should be increased by 20 to 40 numbers for each operation

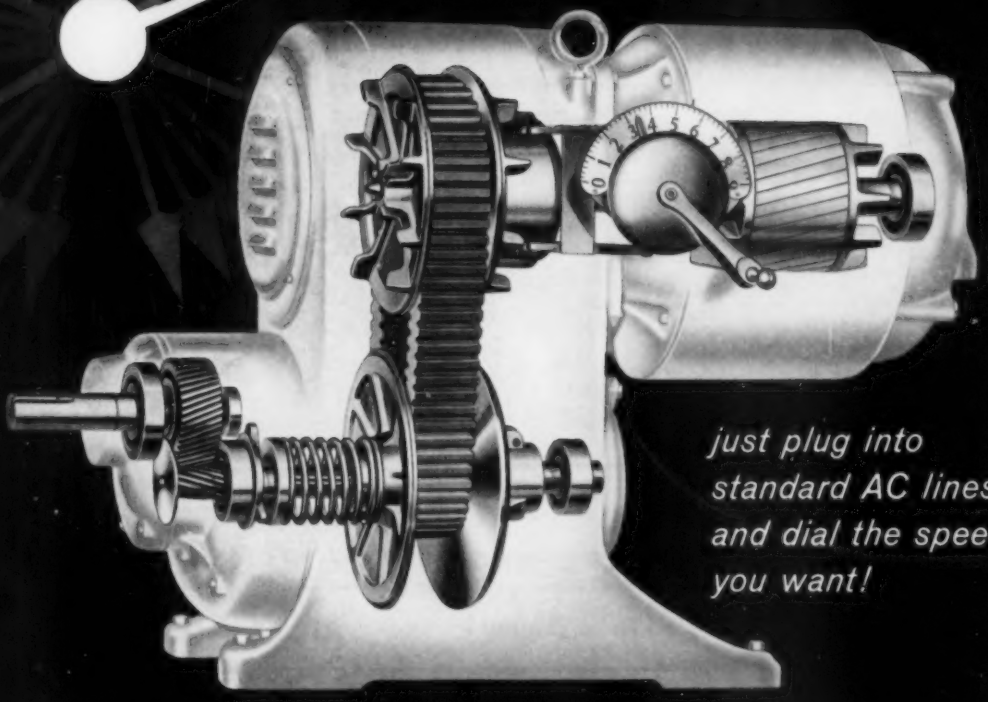
FOR HIGHER FINISHES FROM STANDARD NO. 4 FINISH . . .

These are the methods

MILL FINISH NUMBER	OPERATION	GRIT	WHEEL	ABRASIVE	LUBRICANT	SURFACE FT. PER MIN.	REMARKS
6	Brushing	....	Tampico or similar brush	Powdered pumice with oil applied as paste		1–5000	Finish varies with abrasive and wheel speed
7	Polishing	180	Cloth	Aluminum oxide or silicon carbide*	Tallow or grease stick	7500	May be followed by second polishing with 220–240 grit
	Buffing (cutting)	....	Bias type or sewed-piece buff	Commercial cutting compound (supplied in stick or cake with lubricant)		8–10,000	Use only iron-free compounds; color buffing is for much shorter periods than cutting
	Buffing (coloring)	....	Loose disk or bias type	Commercial coloring compound (supplied in stick or cake with lubricant)		8–10,000 for high finish	
8	Polishing	180	Cloth	Aluminum oxide or silicon carbide	Tallow or grease stick	7500	
	Polishing	240–320	Cloth	Aluminum oxide or silicon carbide	Tallow or grease stick	7500	
	Buffing (for both cutting and coloring)	Same as for #7 finish					

*Manufactured-type abrasives—must be iron-free

any RPM simply on AC!



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CIRCLE 151 READER SERVICE CARD

Ratchet-drive rotary solenoid . . .

permits selection of output torque from any part of over-all torque curve. Angle of rotation can be varied by adjustment of stops. Models are available with left or right hand rotation for continuous or intermittent duty. Ratchets are for 10 and 15° increments. Standard unit operates in temperatures of −65 to 300 F, on 110 v, 60 cps. In quantity, $16.25 each; 4-wk delivery. **Lectronics, Inc, 30 Main St, Brooklyn 1, NY.**

Circle 1, Reader Service Card

Compression fastener . . .

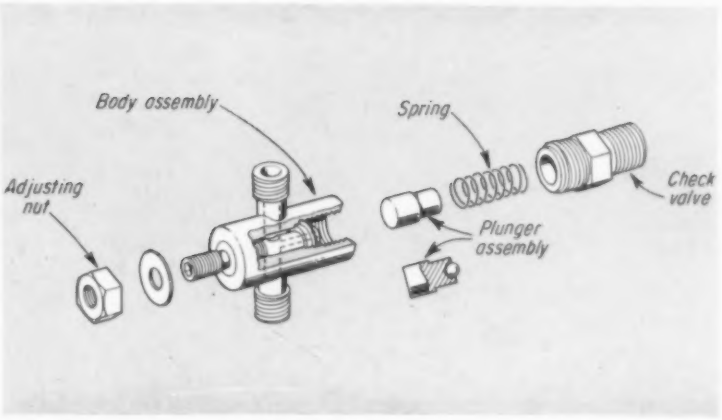
and bushing for applications that simultaneously require fastening of a cylindrical piece to a wall and holding it in place. Threaded hollow bolt has elevated key that depresses to hold cylinder in place when nut, which also affixes assembly to panel, is screwed on. Heat-treated bolt may be serrated inside. Cylinder is inserted through bushing. Adjustment of throw sets compressive load pressure desired. Offered in a variety of sizes. Price for ½-in. size. About 19¢. Immediate delivery. **Barr Machine & Tool Div, Denver Metals & Chemicals Corp, 2130 S Platte River Dr, Denver 23.**

Circle 2, Reader Service Card

Momentary converter valve . . .

provides an adjustable short-duration or bleed output signal to operate most spool-type valves from a sustained pressure input signal. Output signal is adjustable from 0 to 10 sec when operated from an 80-psi source. Cycle rates to 100 cpm are obtainable. Converter operates on inputs of 40 to 150 psi and controls output pressures of 0 to 150 psi. Orifice area controlling output signal is 0.0138 sq in. Housing and internal spool are anodized aluminum and all seals are standard-size neoprene O-rings. Dimensions are 1¼ x 1¼ x 4 in. long. Ports are tapped for ⅛-27 NPT fittings. 2-wk delivery. Price, $45. **Hause Machines, Montpelier, Ohio.**

Circle 3, Reader Service Card



Infinitely-variable Lubricant Valve

Valve is infinitely variable between zero and 0.0032 cu in. Fitting is controlled by position of upper seat of piston inside valve. Upper seat is threaded into body of valve and controls length of piston stroke. Entire delivery range is achieved in four 360° turns of this threaded part; each 45° turn upward increases delivery by 100 millionth of a cubic inch.

Valve delivers lubricant under positive pump pressures (800 to 1000 psi), as do other types of valves in this manufacturer's centralized lubricating system, and operates on same lubrication cycle frequency (from 45 sec up). Manufacturer claims valve makes possible continuous lubrication, without such disadvantages as excess lubricant, product contamination, floor drippage. Valves are $1.90 each. Immediate delivery. **Stewart-Warner Corp, 1826 Diversey Pkwy, Chicago 14.**

Circle 4, Reader Service Card

High-temperature lubricant . . .

is a nonmelting-point grease fortified with purified molybdenum disulfide powder. Recommended for metal, plastics or glass on equipment where lubrication in presence of gases or liquids is required. Said to eliminate formation of gummy substance. It is attacked by aliphatic, aromatic and chlorinated hydrocarbons. Packaged in 2-oz tubes, priced at $1.50 each. Delivery from stock. **Alpha-Molykote Corp, 65 Harvard Ave., Stamford, Conn.**

Circle 5, Reader Service Card

Remote-control slave unit . . .

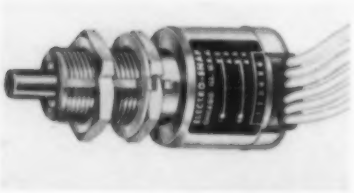
is self-contained and completely hydraulic. Slave piston and master control lever maintain synchronization at all times. Slave unit can be mounted in any position and connected to governors, throttles, valves, equalizers, clutches and similar devices for remote control or positioning purposes. Integral filler-bleeder fitting eliminates need for accessory pressure equipment. Adjustment of equalizer valves permits relative positioning of master lever and slave piston when filling and bleeding have been completed. Master unit automatically compensates for fluid expansion and contraction due to temperature variations. No pressure-actuated or spring-loaded valves are used. System is said to be unaffected by vibration. Body of the valve unit measures 2½ x 1⅛ in.; piston is 3⅞ in. long over-all. Stroke is 1 in. with thrust capacity of up to 1000 lb. Straight line unit is $122.50. About 2-wk delivery on standard units. **Hydronic Co, 12685 Arnold Ave, Detroit 39.**

Circle 6, Reader Service Card

. . . CONTINUED ON PAGE 104

Pneumatic exhaust valve . . .
for rapid exhaust of air downstream when air pressure drops upstream. Used in pneumatic braking and other systems involving long pneumatic line. Has Teflon check. Operating pressure is 1000 psi; operating temperature range is –65 to 160 F. Envelope dimensions are $\frac{7}{8}$ x $1\frac{3}{8}$ x $1\frac{33}{64}$ in. Weighs $\frac{1}{10}$ lb. **Walter Kidde & Co, Inc, 67 Main St, Belleville 9, NJ.**

Circle 7, Reader Service Card



Multicircuit limit switch . . .
for any exposed control or indicating application on aircraft or industrial machines. Stainless steel or monel is used for all exposed parts. Mounts anywhere through one mounting hole, infinitely adjustable within $\frac{7}{8}$ in., wire-locking. Separate terminals permit many circuit combinations. Has two SPDT contact arrangements. Operating force is 9±3 lb; overtravel force, 30 lb max. Electrically rated 28 v dc, 4 amp resistive, 2 amp inductive, sea level to 100,000 ft. Operates in ambient temperatures of –100 to 221 F. Weighs about $2\frac{1}{4}$ oz. Available in 12 variations. **Switch Div, Electrosnap Corp, 4230 W Lake St, Chicago 24.**

Circle 8, Reader Service Card

One-part epoxy adhesive . . .
performs satisfactorily in temperatures of –67 to 392 F, after a short heat-curing operation. A brown paste in uncured form, compound can be applied to any surface without sagging or running. Said to have excellent adhesion to metals, ceramics, glass, cement and other temperature-stable materials. Chemically resistant to most fluids. Compound has shelf life of over 1 yr if kept below room temperature. Sample kit is $2.95. Price is $1.70 per lb in 1-gal. quantities (gal. weighs about 9 lb), FOB Providence. **Isochem Resins Corp, 221 Oak St, Providence 9, RI.**

Circle 9, Reader Service Card

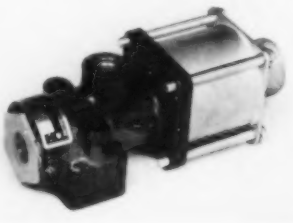
Subminiature screw . . .
is self-sealing, has a 2-56 NC thread and a slotted head. Groove underneath head accommodates silicone rubber O-ring. When installed, O-ring compresses to form vibration-resistant seal. O-rings are said to be unaffected by water, steam, ozone or hydraulic fluids and maintain sealing action under internal and external pressure. Can be reused. Standard units are stainless steel. Available in lengths from $\frac{3}{16}$ to $\frac{7}{16}$ in. in $\frac{1}{16}$-in. increments. **APM Sales Corp, 252 Hawthorne Ave, Yonkers, NY.**

Circle 10, Reader Service Card

Adjustable reset timer . . .
has direct-reading dial in 0.01 gradations. Operates on constant-duty solenoid with drive clutch for instant engagement. Clutch solenoid and motor can operate independently. Switch is rated 20 amp, 125 v ac, SPDT. Input is 12.25 w. Available in several different models that provide timing intervals for adjustable ranges from nominal 0 to 8.2 hr. Models are for 25, 50 and 60 cps, 110 v ac. Repeat accuracy is said to be 0.1% over the total range. Requires minimum mounting space. **Turner Industries, Inc, 2 Harding Ave, Endicott, NY.**

Circle 11, Reader Service Card

Hydraulic pressure switch . . .
for systems that require a pressure sensor to actuate electrical apparatus. Unit operates in ambient temperatures of –65 to 275 F and meets military specs for vibration performance. Operating point is adjustable from 500 to 2000 psi and 2000 to 3500 psi. Snap-action SPDT contact rating is 5 amp resistive or 2.5 amp inductive at 28 v dc. A choice of lapped piston or O-ring sealed piston hydraulic actuator is offered. Both have a seepage chamber that is between a high- and a low-pressure seal and vented to a return port. Leakage is said not to exceed 3 cc per min or 1 drop in 100 cycles of operations, respectively, at 3000 psi. Pressure level at return port will not affect set point because of a balanced piston design that nullifies this pressure factor. **Consolidated Controls Corp, Bethel, Conn.**



Circle 12, Reader Service Card

High-strength fasteners . . .
are said to be 64% stronger than standard shear fasteners now in use. A companion series for temperatures to 900 F is said to be 71% stronger at max temperature than currently used fasteners. Twelve shear-joint families, representing different bolt-head configurations, strength levels and application temperatures are available. Joints have min shear strength of 156,000 psi. This compares with 95,000 psi for NAS 464 and 333 shear bolts, next strongest aircraft standards. Bolts are heat-treated to a tensile strength of 260,000 psi. High-temperature series has a min rated shear strength of 120,000 psi at 900 F. Shear joints range in size from $\frac{1}{4}$ through $\frac{3}{4}$ in. dia. **Standard Pressed Steel Co, Jenkintown, Penna.**

Circle 13, Reader Service Card

Continuous-level gage . . .
measures liquid levels in totally enclosed containers of any size and dimensions with accuracy to a few hundredths of an inch. Continuous readings are given in depth or volume. Radioactive source in a float follows liquid level along a path predetermined by guide lines. Radiation is detected by an exterior scintillation detector. **Radiation Counter Laboratories, Inc, 5121 W Grove, Skokie, Ill.**

Circle 14, Reader Service Card

Hydraulic power check . . .
is self-contained, single-acting unit for feed control of air cylinders and other machine feed components. This model will check thrust loads up to 1500 lb on forward or reverse stroke and unrestricted movement on opposite stroke. When applied to pneumatic cylinders, it prevents chatter and flutter. Feed is unaffected by variations in power thrust. Unit is installed by attaching oil-filled, spring-loaded cylinder to a fixed portion of machine,

. . . CONTINUED ON PAGE 106

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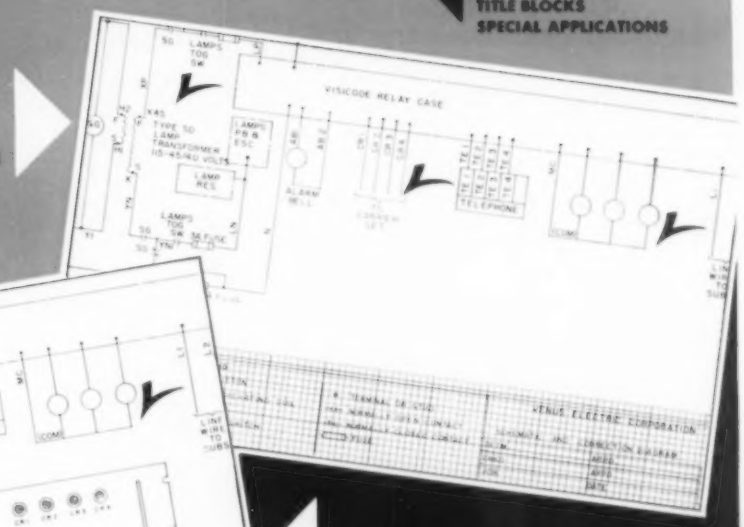

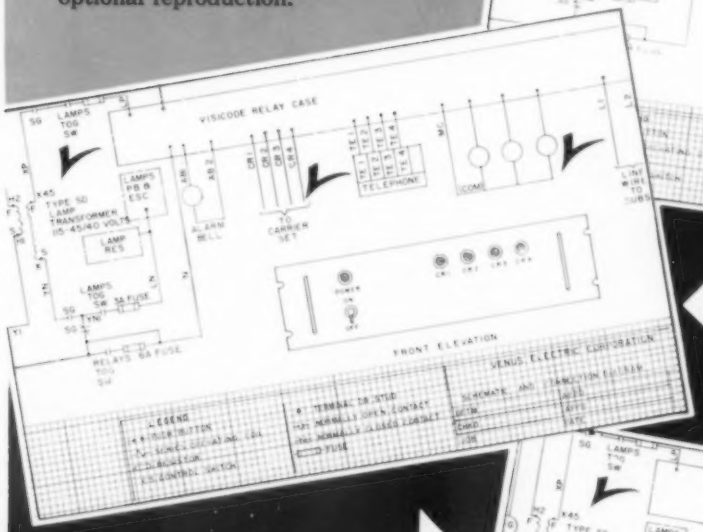

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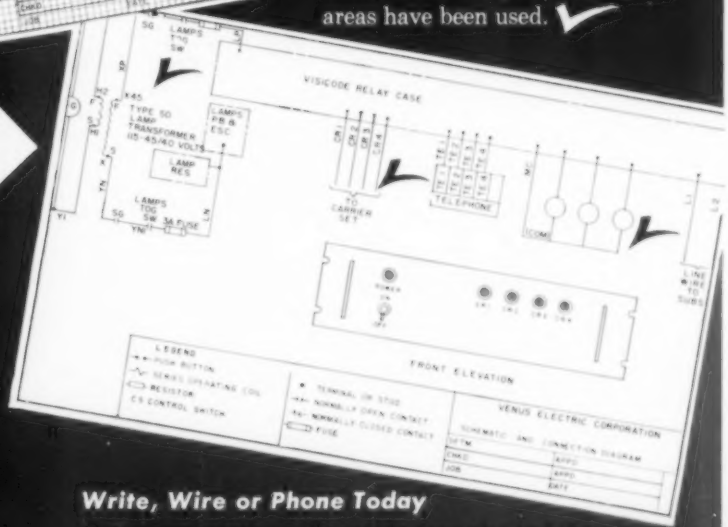

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Newark Wire Cloth COMPANY

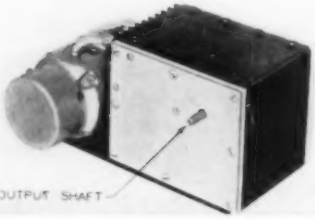
351 VERONA AVENUE • NEWARK 4, NEW JERSEY

and piston rod to member to be controlled. Distance of travel is determined by positioning of stop nuts on rod, in relation to bracket, while speed is controlled by external adjusting screw. Available in six sizes with strokes from 2 to 12 in. Overall collapsed lengths range from 18¼ to 26¼ in. Cylinder bore is 1.385 in. on all models and piston rod is ½ in. dia. **Appco Corp, PO Box 6, Olmsted Falls, Cleveland.**

Circle 15, Reader Service Card

Budget-priced bearings . . . for shafts from $\frac{3}{8}$ through 2 in. dia. Flanged or radical mounting units have press-formed, case-hardened inner and outer races and a full complement of heat-treated and ground, high-carbon steel balls. Available prelubricated or plain for light-duty, intermittent operation. **Freeway Washer & Stamping Co, Bearing Div, PO Box 1756, Cleveland 5.**

Circle 16, Reader Service Card



Multipurpose transmission . . . unit for Class 3 commercial use contains five gear sections and covers a ratio of 128:1 in eight steps. Instantaneous speed-changing requires no gear change. Has low-inertia gear train and requires no lubrication. Gear sections utilize overriding clutches and rotation is confined to one direction for min lash. Output shaft is $\frac{5}{16}$ in. dia. Output torque is 128 in.-oz; max breakaway torque, 6 in.-oz; top running torque, 4 in.-oz. Bearings are Class I. Controlled by optional pushbutton switch. Housed in cast aluminum frame with aluminum side plates. Unit weighs 6½ lb. Life tests have been run continu-

(Continued on page 110)

Waldes Truarc Prong-Lock Ring Eliminates Springs, Washers, Takes Up End-Play

WALDES TRUARC
SERIES 5139 RETAINING RING*

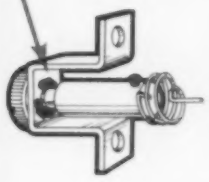
application: external for shafts
range: 3/32" through 7/16"

*U. S. Pat. No. 2,755,698

After radial application, the Waldes Truarc Prong-Lock retaining ring locks and holds securely in its groove by means of two prongs. Because of its resistance to radial displacement, the ring may be used as a shoulder for rotating parts. Thrust-load capacity ranges from 80 to 700 lbs. for sizes from 3/32" to 7/16". Bowed construction provides end-play take-up, often eliminating springs, washers and accessory devices.

Rings replace cotter pins, spring-washers; save $68.00/M

Mason-Neilan Division of Worthington Corp., Norwood, Mass., uses two Waldes Truarc Series 5139 Prong-Lock rings on its pressure controller to secure pivots through which a right angle micrometer adjustment screw passes. Each ring replaces hairpin-type cotter pin and bowed washer... provides necessary tension to prevent adjustment screw from shifting. Manufacturing costs were reduced by $68 per 1,000 units.



Ring replaces locknut, eases control calibration

On a differential pressure control mechanism, Taylor Instrument Companies, Rochester, N. Y., replaced a locknut and eliminated a costly threading operation with a series 5139 Prong-Lock ring. Also eliminated is the loosening and tightening of the locknut before and after each calibration setting. Spring action of the ring securely holds the calibration setting.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get:

Statistically Controlled Quality from engineering and raw materials to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today . . . let our Truarc engineers help you solve design, assembly and production problems . . . without obligation.

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RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, N. Y.

Waldes Kohinoor, Inc., Long Island City 1, N. Y.

Please send me additional information and engineering data for the Truarc Prong-Lock Ring, Series 5139.

Name_____

Title_____

Company_____

Business Address_____

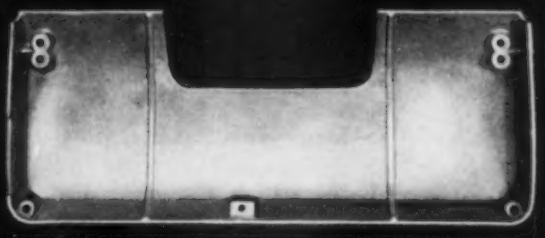
City_____ Zone____ State_____

PN-100

Consult the Yellow Pages of your Telephone Directory for name of Local Truarc Factory Representative and Authorized Distributor. Look under "Retaining Rings" or "Rings, Retaining."

©1958 Waldes Kohinoor, Inc.

Die Castings Cut 10 Pounds off Frameweight of New Royal Standard



CASE HISTORIES FROM MT. VERNON FILES

"Never before has a standard typewriter featured so many new improvements. From Twin-Pak to Touch, this new Royal Standard opens up a whole new world of breathtaking ease and economy." It is a fine example of beautiful design, excellent engineering and wise choice of materials.

Because of the remarkable strides made by the die casting industry in the production of sound economical aluminum die castings, the major portion of the framework of all the Royal Typewriters are die cast. Through the use of aluminum die castings having cored holes, close tolerances and thin walls ribbed for maximum strength, Royal engineers have reduced the weight of the framework of the Standard model from 15 pounds to approximately 5 pounds . . . an impressive savings of 10 pounds.

All told, the Royal McBee Corporation uses from 2½ to 3 million pounds of aluminum die castings yearly and the end of die casting usage is not in sight. Royal engineers are constantly alert to additional die casting applications because of the tremendous savings in man and machine hours which are achieved through the elimination of costly secondary operations.

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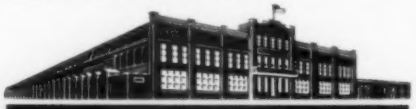

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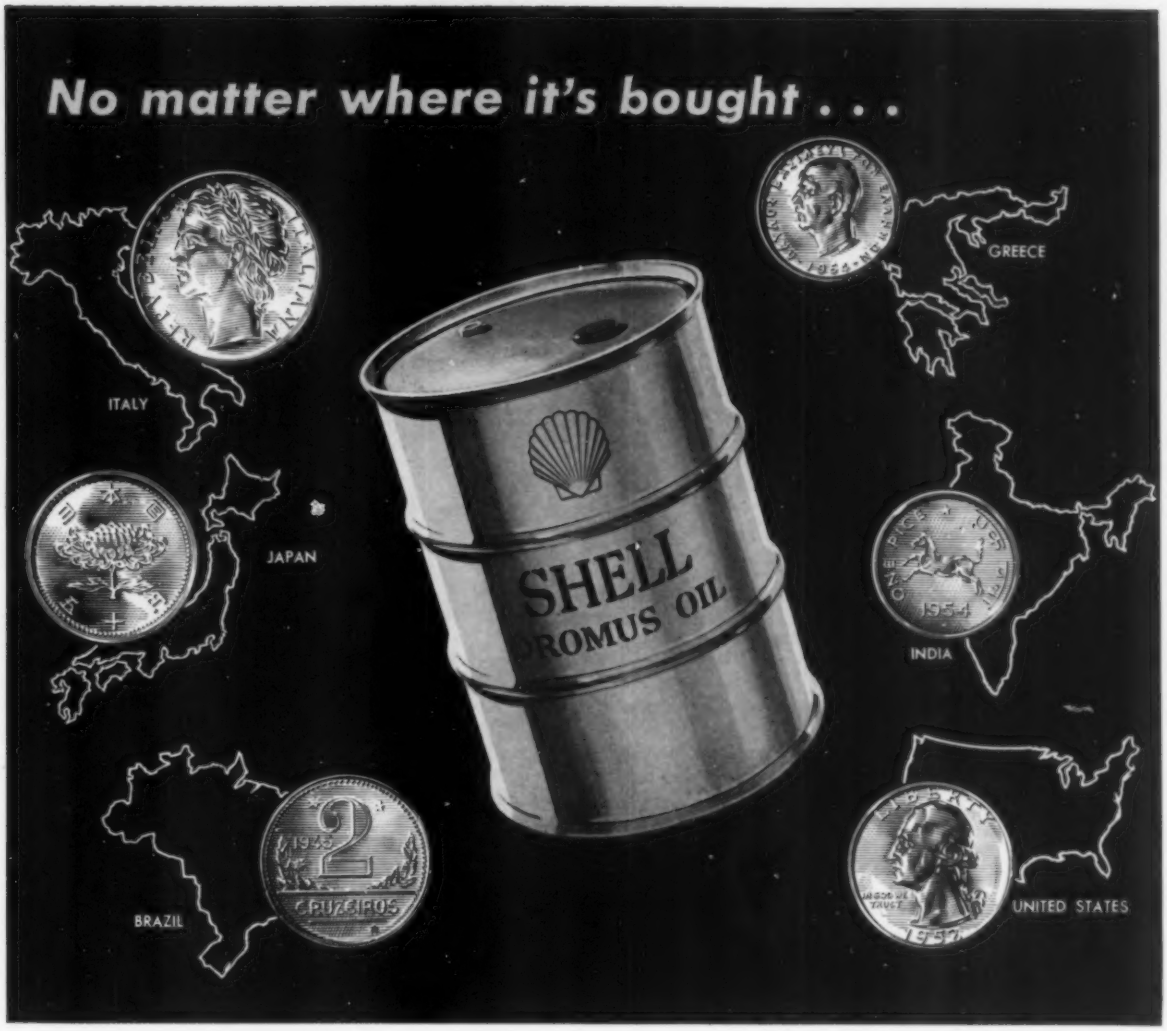

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Shell Rimula Oils—for heavy-duty diesel engines

Shell Turbo Oils—for utility, industrial and marine turbines

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Shell Macoma Oils—for extreme pressure industrial gear lubrication

Shell Voluta Oils—for high-speed quenching with maximum stability

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Shell Dromus Oils are a quality line of soluble cutting oils that permit higher speeds and greater feeds while extending tool life. They have excellent wetting and cooling properties and are not sticky or greasy.

Dromus* Oils have the added advantage of being easy to mix in hot or cold, hard or soft water. They form emulsions which remain stable in any concentration required in the shop.

When your machine tool customers abroad specify Dromus Oil, they will enjoy the same efficient performance your domestic customers rely upon.

For more information, write Shell Oil Company, 50 West 50th Street, New York 20, New York, or 100 Bush Street, San Francisco 6, California.

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SHELL DROMUS OILS

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ously over 100-hr periods. **Hamilton Watch Co, Hathaway Instrument Div, 5800 E Jewell Ave, Denver 22.**

Circle 17, Reader Service Card

Lubricant dispenser . . .

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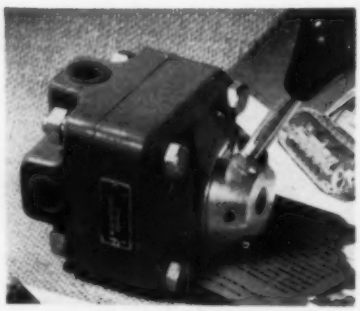
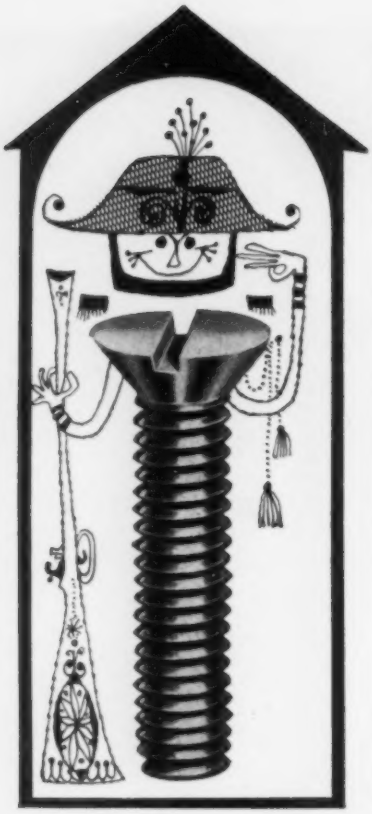


Rotor-operated valves . . .

in 2-, 3- and 4-way models are offered in 2½- to 14-gpm capacities, with operating pressures to 3000 psi. Manually operated valves have open or closed center; handles detent-positioned or spring-centered. Valves incorporate a lapped seal to eliminate internal leakage. Rotor rides on roller bearings for ease of operation, even when fully loaded. Seal and rotor glide on each other, wiping and lapping with

(Continued on page 114)



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Gentlemen: Please send complete specification data and samples of Alcoa Aluminum Fasteners.

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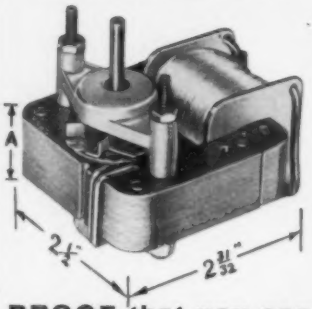
1/1600 H.P. to 1/25 H.P.

MILLIONS now in use . . .



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RELY on GI

Meet an all-around performance champion. GI's husky, versatile Model "A" motor. **Proved dependable millions of times over,** it's the power choice of the nation's great-name manufacturers . . . setting an amazing performance record in countless applications from phonographs to kitchen fans to pumps. If dependability is your aim, Model "A" is your motor!

MODEL "A" two-pole shaded pole motor available in various lamination thicknesses. Precision constructed for reliable, long hard usage. Perfectly balanced for smooth, quiet, operation.

MODEL	HP 3000 RPM	LOCKED TORQUE in./oz.	MAXIMUM TORQUE in./oz.	FREE SPEED RPM	A
A-3-CW A-3-CCW	1/500	0.7	1.1	3360	3/8"
A-4-CW A-4-CCW	1/350	1.0	1.4	3380	1/2"
A-5-CW A-5-CCW	1/180	1.7	2.7	3430	5/8"
A-6-CW A-6-CCW	1/130	1.9	3.3	3430	3/4"
A-7-CW A-7-CCW	1/100	2.1	3.8	3500	7/8"
A-8-CW A-8-CCW	1/90	2.5	4.5	3480	1"
A-9-CW A-9-CCW	1/70	2.7	5.3	3520	1 1/8"
A-12-CW A-12-CCW	1/60	3.0	6.5	3500	1 1/2"
A-14-CW A-14-CCW	1/50	3.1	7.0	3490	1 3/4"
A-16-CW A-16-CCW	1/45	4.0	7.5	3490	2"

Standard shaft diameter .1817, 1/4" shaft available if desired.

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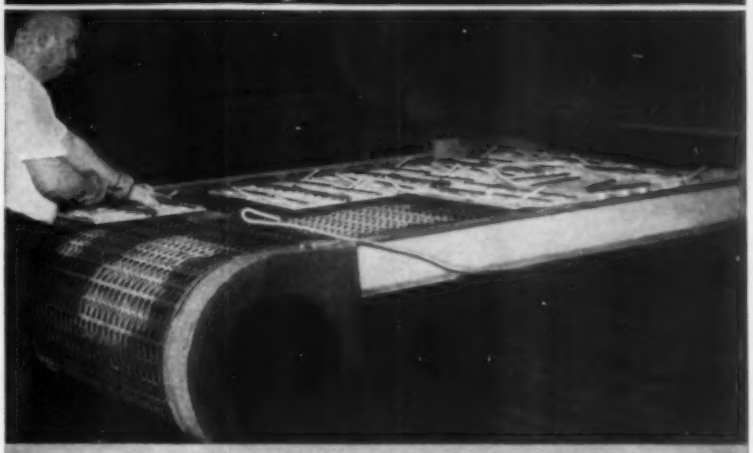

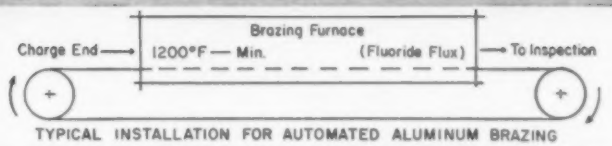

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Here's a belt that not only shrugs off hot atmospheres and corrosive fluxes, but helps process metal parts more uniformly—and in less time. Moving continuously through the furnace, the Cambridge Belt allows heat to circulate freely through its open mesh and around the product for thorough treatment.

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CONTINUOUSLY MOVING BELTS ELIMINATE BATCH PROCESSING—give faster, more economical production; reduce manual handling.

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Whether you design machinery for your own use or for resale, your Cambridge Field Engineer can explain how the many advantages of Cambridge Belts make continuous processing practical and economical. And, he'll recommend the belt size, mesh or weave—in the metal or alloy—best suited to your needs. He's listed in the classified phone book under "BELTING, MECHANICAL." Or, write for FREE 130-PAGE REFERENCE MANUAL giving mesh specifications, design information and metallurgical data.

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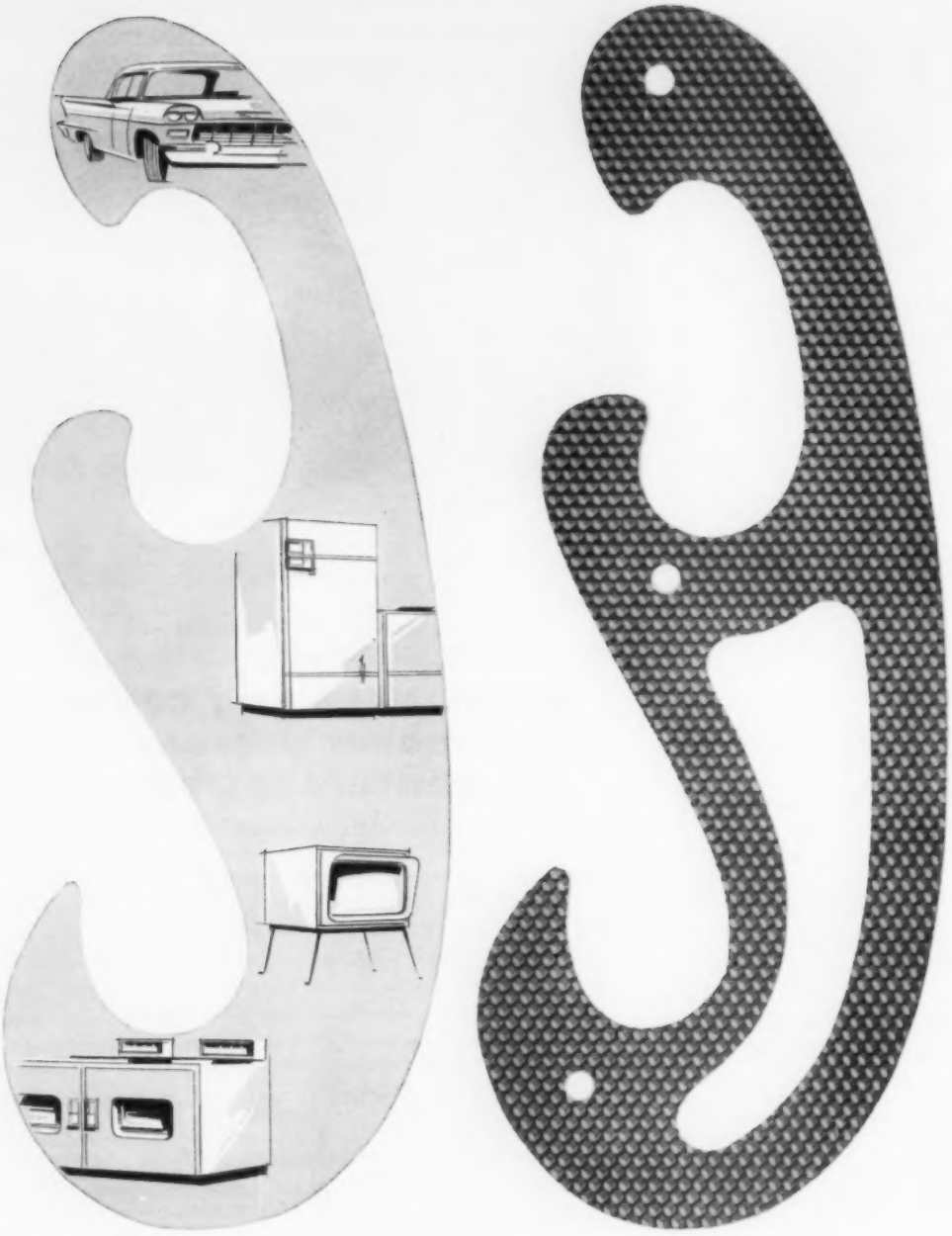

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Count on Firestone production to solve your biggest problems with colorful, low-cost, mass produced trim for automotive products and home appliances.

Whether you want your trim designed, or the cost of your present design trimmed, you want Firestone Fashionized Aluminum. And you want Firestone's nearly 50 years of experience in metal fabrication combined with the most completely automated color-anodizing facility in the industry. From preliminary sketch to mass production, the full technical staff and resources of Firestone stand ready to save you time, trouble and money—to show you shortcuts to the brightest parts in the business, in sizes up to seven feet long! Write, phone or wire today for facts about Fashionized Aluminum.

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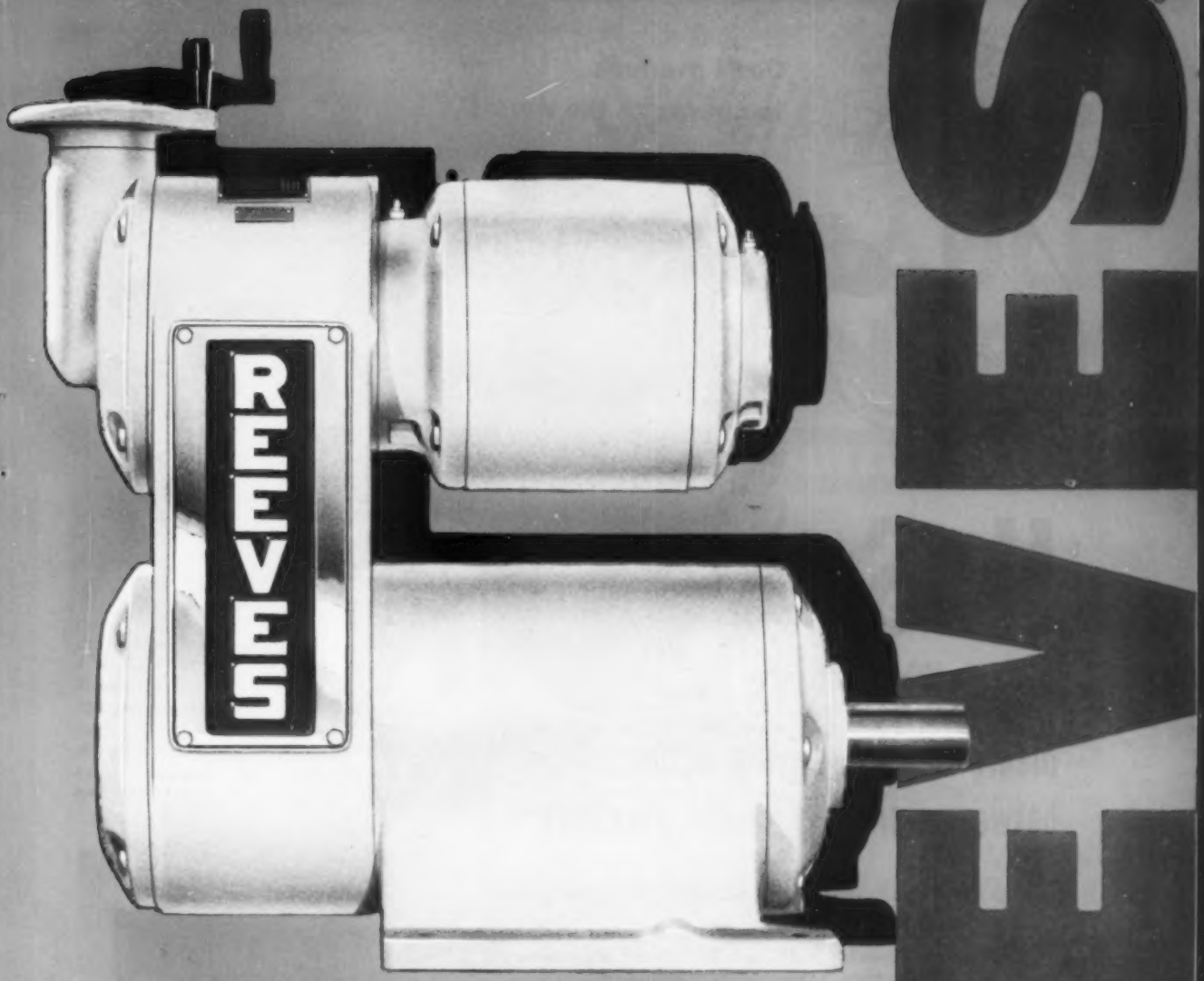

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Sanitary Type

VARI-SPEED MOTODRIVE

• Especially designed for variable speed applications *wherever cleanliness* is a factor. Every sanitary feature has been incorporated: durable white enamel finish; machined mounting surface fits flat; bolt recesses are slanted for drainage; ample cleaning room between motor and reducer housing; no sharp edges; gaskets or seals give moisture protection to the drive at the output shaft, speed indicator and inspection plate; exterior speed seal meets inspection requirements; and special end bells make drive and motor a completely Sanitary Type unit.

Available in hundreds of assemblies; fractional through 10 hp . . . no reducer, single, double or triple reducer units . . . vertical, 45° or horizontal models . . . "C" or "Z" flow styles . . . and a full range of accessories and manual or automatic controls. For complete details, write for Bulletin K38-M588.

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DIVISION OF **RELIANCE** ELECTRIC AND ENGINEERING CO. •

Don't overlook the power of the worm!

H&S

WORM-GEAR SETS insure smooth driving action between perfectly mated members

Check these important advantages for your power transmission needs:

Smoothness of Operation • Ability to Carry Heavy Shock Loads
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Horsburgh and Scott worm-gear generating methods guarantee perfect mates in each set, with worm threads and gear teeth having identical pressure angles and tooth contours. Resultant smooth conjugate action delivers maximum right angle power transmission with minimum power loss. H&S gives each set a controlled inspection on the correct center distance for tooth contact, backlash and smoothness.

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every handle movement. Rotor, seals and bearings may be replaced without disturbing piping or valve connections. **Clark Engineering & Mfg Co Inc, 1820 Layard Ave, Racine, Wis.**

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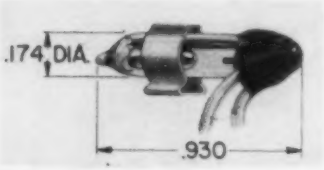
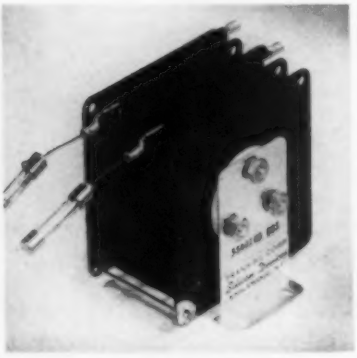


Mercury switch . . .

weighs 1.8 gm with leads attached and offers sensitive operation. Low actuation requirement facilitates gang-mounted assemblies. Switch may be mounted in any position through 360° around its longitudinal axis. May be actuated by slow, snap or fast-tilting action. Contact arrangement is SPST. Switch is electrically rated 1 amp, 30 v ac or dc; 0.5 amp, 110 v ac or 0.75 amp, 110 v dc, for resistive loads. On inductive loads, it is rated 0.75 amp, 30 v ac or dc with inrush at 2½ times full load. Designed for devices where min operating energy is available and space is limited. **Micro Switch, Freeport, Ill.**

Circle 20, Reader Service Card



Self-protecting rectifiers . . .

eliminate high-cost protective devices, are said to almost halve production costs. Diffused technique makes it possible to protect silicon rectifiers against short circuits, high-surge currents and sustained overloads with standard commercial fuses. Fuse rating of about 160% of rms current is recommended. However, rectifiers will take out fuses rated at 300% of rms current value with max protection to the balance of the circuit components. Rectifier stacks are available in half-wave or full-wave configurations from 1 to several thousand amp, with peak inverse ratings

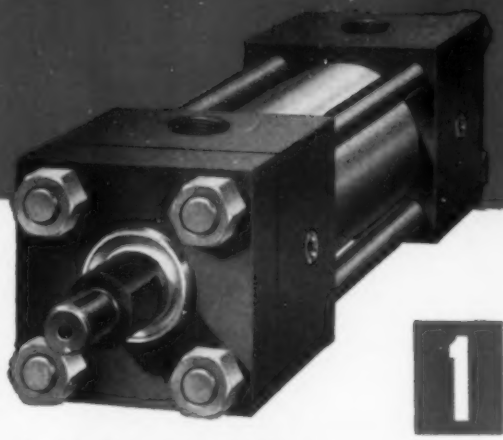
(Continued on page 116)

SEAL FAILURE MEANS CYLINDER FAILURE

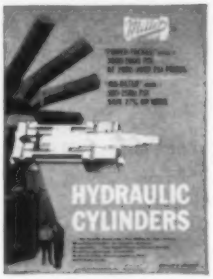
Petroleum base, fire-resistant and special hydraulic fluids cause distortion and rapid deterioration of the seals currently used in many hydraulic cylinders, resulting in costly repairs and cylinder failure. (Seals made of synthetic rubber are not compatible with even 50% of available commercial petroleum base fluids and the life of such seals is materially reduced at operating temperatures above 150° F.)

Specify Miller HYDRAULIC CYLINDERS

FOR UNLIMITED SEAL LIFE!



Request Bulletin JH-104N for complete data plus helpful charts on column strength, cylinder forces, factors of safety, acceleration, pipe pressure losses, etc.



1 ALL TEFLON* SEALED Against External Leakage

TEFLON is impervious to all known hydraulic fluids, including all fire-resistant and special types – and withstands temperatures from –100°F. to plus 450°F.

TEFLON SHEF SEAL AT TUBING ENDS

No blind assembly. Is
Shear-proof
Heat-proof
Extrusion-proof
Fluid-proof

TEFLON SEALS ON PISTON ROD AND BUSHING

Teflon rod flange seal requires no adjustment. Teflon bushing seal is shearproof. Teflon wiper keeps dirt out.

TEFLON SEALS ON BALL CHECK AND ADJUSTING SCREW

Non-protruding, self-locking, cushion adjusting screw interchangeable with ball check for easy access.

2 CASE-HARDENED CHROME PLATED PISTON RODS

Provide foolproof protection against seal failures resulting from rod damage. The Miller case-hardened rods (50-54 Rockwell C) give practically complete immunity to damage from hammer blows, wrench-dropping, mishandling, etc. The hard chrome plating over the case-hardened rods protects against scratch-damage and rust.

AVAILABLE IN TWO TOP QUALITY LINES

JOB-RATED
Model "J"

PRICE SAVINGS OF 27% OR MORE!

19 mounting styles, all strokes, cushioned and non-cushioned. Large selection for immediate shipment.

BORE	SEVERE OPERATING CONDITIONS	MODERATE OPERATING CONDITIONS	YOU SAVE THIS % IN PRICE OVER STANDARD 2000-3000 PSI CYLINDERS
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2	1500	2500	27%
2½	1000	1500	28%
3¼	1500	2500	32%
4	1000	1500	35%
5	800	1200	37%
6	800	1200	43%
8	500	800	50%
10	500	800	71%
12	500	800	76%
14	500	800	*Not Available in 2000-3000 PSI*

POWER-PACKED
Model "H"

50% More Power Per Cylinder Dollar!

For
3,000-5,000 P.S.I.

1½" through 12" bores, 17 mounting styles, strokes up to 22 ft., cushioned and non-cushioned. Large selection for immediate delivery.

*DuPont trademark for its tetrafluoroethyline resin

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AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
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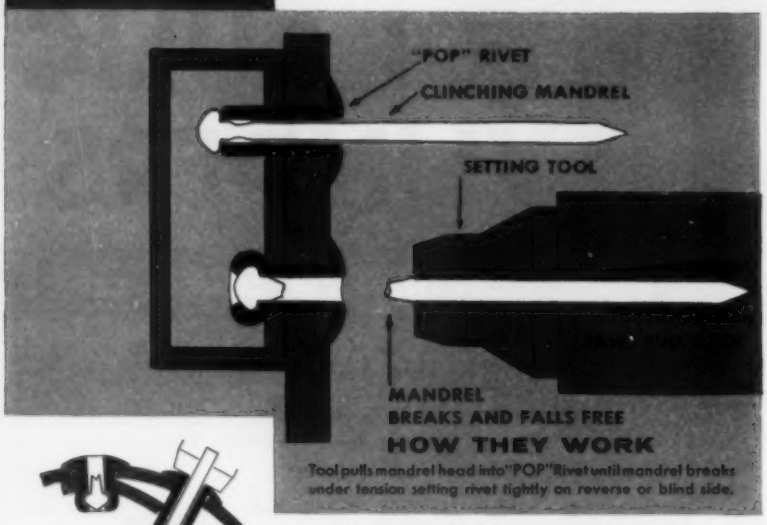
5-Year Study Proves

Each "POP" RIVET Saves 4.9¢ on Installed Costs


"POP" RIVET
CLINCHING MANDREL
SETTING TOOL
MANDREL
BREAKS AND FALLS FREE
HOW THEY WORK
Tool pulls mandrel head into "POP" Rivet until mandrel breaks under tension setting rivet tightly on reverse or blind side.

High Clinching Action
Pulls parts together with up to 600 lbs. squeeze. Eliminates need to clamp.

Wide Grip Range
Simplifies inventory, purchasing, inspection. Same length "POP" Rivet holds tight through thick or thin.

Vibration Proof
"POP" Rivets cannot back out or become loose. Ensures tight assembly for years of use.

Least Back-Up Space
Strong, high strength "POP" Rivets need only enough back-up space to provide room for set head. Gives more compact design.

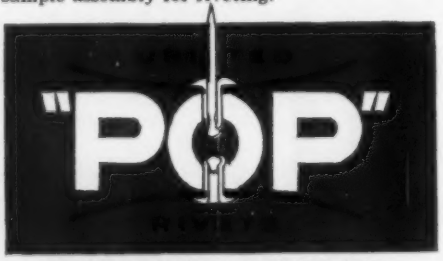
Saves 4.9¢ each over other blind rivets
Saves 1.8¢ each over solid rivets

Replace 100,000 solid rivets with strong, high clinch "POP"® Rivets and you save $1,800. Use 100,000 time-tested "POP" Rivets for blind assembly work and you save $4,900.

No other rivet equals the savings potential in *installed costs* provided by "POP" Rivets. The Martin Company saved $223,000 on one fifty-plane contract alone — and with today's rapidly increasing costs, even greater savings are possible. In addition, the extraordinary design flexibility of these rivets gives engineers many opportunities for simplified product design.

Extreme light weight, high production gun — only 2 lb., 3 oz. sharply reduces operator fatigue. Means more rivets set per hour right on the assembly line — rates as high as 1200 per hour even with unskilled operators.

Whether you make planes, missiles, cars, trucks, trailers, metal awnings, furniture, boats, or toys, you can cut costs, simplify design and add assembly convenience with "POP" Rivets. Call or write for our literature now — before you forget. Better still, send a sample assembly for riveting.



"POP" RIVET DIVISION
UNITED SHOE MACHINERY CORPORATION
West Medway, Mass. • Phone: Keystone 3-6611

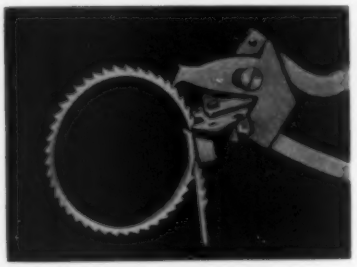
in 50-v multiples to thousands of volts. Hermetically sealed, for magnetic amplifier and power supply applications, units operate without derating in temperatures of −85 to 302 F. Efficiency is said to be up to 99%, with a regulation characteristic of less than 1 v per cell forward drop and low reverse leakage. **Trans-Sil Corp, 55 Honeck St, Englewood, NJ.**

Circle 21, Reader Service Card

Electrical safety system . . .

for industrial equipment and vehicles eliminates short-circuit fire hazards difficult to detect until damage is done. Electrically operated pushbutton control in driver's compartment disconnects battery instantly in case of circuit trouble; solenoid valve in fuel line cuts off fuel supply. Incorporated in circuit is a tipover switch that energizes the system if vehicle tips more than 60° in either direction. **Safety Enterprises Inc, 530 Fifth Ave, New York 36.**

Circle 22, Reader Service Card



Wire-securing pliers . . .

for fast, positive bundle tying with self-locking nylon straps. Wire bundles secured in this manner are said to be impervious to vibration and extraneous loading. Double-detented buckles eliminate stress concentration. Offered in miniature as well as standard sizes. **Dakota Engineering, Inc, 4315 Sepulveda Blvd, Culver City, Calif.**

Circle 23, Reader Service Card

Vibrating capacitor . . .

is said to have nominal capacitance of 20 micromicrof. Contact potential is less than 25 mv positive or negative, with drift of less than 0.2 mv in 24 hr at constant temperature, less than 0.4 mv change from 77 to 122 F, and less than 10 mv in 1 yr. Converts greater than 12% ratio of ac rms voltage output to dc voltage applied at specified excitation, 4 v rms, 50 to 200 cps, coil resistance of 25 ohm. Requires no shock mounts. Capacitor assembly is hermetically sealed and filled with inert gas to minimize drift. Unit, in

(Continued on page 120)

Short cuts with Recordak Microfilming

Latest report on how this low-cost photographic process is simplifying routines for more than 100 different types of business . . . thousands of concerns

Ford, Bacon & Davis, Inc., leading consulting engineers, are prominent users of Recordak Precision Engineering Drawing System. Shown comparing end result with original drawings are, l. to r.: *Bill Poor, Russ Westerhoff, Charlie Schneider.*

NEW SYSTEM PUTS COMPLETE ENGINEERING DRAWING FILES AT FINGERTIPS

NEW YORK, N. Y.

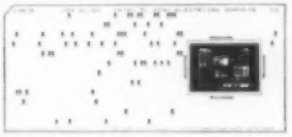
Much faster reference to engineering drawings, lower blueprint costs, and greater security are assured by new Recordak system at Ford, Bacon & Davis, Inc.

The firm simply sends out its bulky files of drawings—gets back trim decks of cards. Recordak's local laboratory, *using new 35mm microfilming techniques and quality controls,* produces needle-sharp images on uniform backgrounds from drawings of all ages, sizes and colors. Then these frames of low-cost 35mm film are mounted in standard tab-size Filmsort aperture cards, which have been punched and verified to allow mechanized sorting and tabulating.

Under the new system, the need for reference blueprints will be sharply reduced. Instead, Ford, Bacon & Davis engineers will be able to check any drawing immediately in film readers. Whenever needed, handy-sized work prints can be made directly from the aperture cards . . . as can duplicate film-cards for use in branches. (The high quality of these reproductions also traces back to Recordak's unique microfilming methods and controls.) Meanwhile, the "master" film copies can be stored off the premises for extra protection against loss.

Mail Coupon Today! See how drafting rooms large and small save with new Recordak system.

"Recordak" is a trademark



Now drawings of all sizes can be copied accurately on low-cost 35mm film

Your filmed drawings can be viewed in Reader . . . or work prints made directly from cards

RECORDAK

(Subsidiary of Eastman Kodak Company)

originator of modern microfilming

—now in its 31st year

MAIL COUPON TODAY

RECORDAK CORPORATION, 415 Madison Ave., New York 17, N.Y.

☐ Send free booklet describing Recordak Precision Engineering Drawing System

☐ Send free booklet on short cuts in office work

JJ-10

Name_____ Position_____

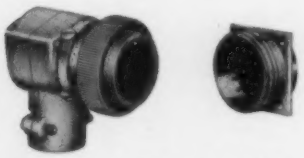
Company_____ Type of business_____

Street_____

City_____ State_____

K (STANDARD)

For Aircraft, Electronic, Instrument, Military, Missile, Industrial and Commercial Applications.

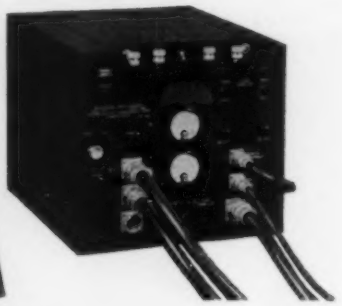


Standard K and RK...in straight and angle 90° plugs, wall mounting receptacles. Conduit and clamp entry types. 1 to 82 contacts in 213 different insert arrangements. 10-, 15-, 30-, 40-, 60-, 80-, 115-, and 200-amp. silver-plated brass contacts. High quality phenolic, melamine, and formica insulators. Cadmium-plated aluminum alloy shells. Flashover voltages: 1100 to 5000v 60cps ac rms.

connect with CANNON PLUGS

APPLICATION

Application of R and RK connectors on a recording oscillograph.



original aircraft, electronics, sound, and all-purpose line

KH, RKH
(HERMETICALLY SEALED)

For Use Under Critical Pressure and Leakage Conditions

Hermetically sealed connectors... with steel shells, steel contacts, and Can-seal glass insulators, fused to shell and contacts. *True hermetic sealing.* Electro tin plating over cadmium plate over copper flash provides highly receptive surface for soldering and corrosion resistance.

STEEL SHELL FIREWALL

For Open Flame Protection Against High Temperatures

FW and FWR Cannon K Firewall Connectors... available in straight and angle 90° plugs, wall mounting receptacles. Inserts of phenolic or fireproof inserts of glass-filled materials. Crimp type contacts. Cannon made the first firewall connector and continues the leader in this important field.

RECORDER CONNECTOR

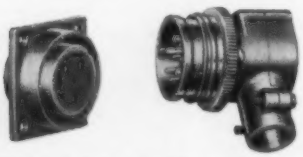
For Telephone "Beeper" Connectors

SK-M7-21C...Widely used on two leading makes of telephone recorded connector units known as "beepers" because of the signal required by law in such recordings.

special acme thread • rugged construction • variety of coaxials • integral clamps

RK
PLUG AND RECEPTACLE

For Flush or Semi-Flush Mounting



RK plug and pin assemblies are equipped with an external threaded coupling nut which is the reverse of the standard K series. Note, RK will not mate with K's.

RLKL and LKL
(TV SWITCHING PANEL)

For TV Panel Switching

Quick Connect and Disconnect RLKL Plugs... designed for one-hand fast disconnect use on TV station program switching panels. Feature a quick coupling means. Latchlock secures plug to mated fitting (RLKL receptacle). Thumb pressure releases it.

K ACCESSORIES

Straight and Angle 90° Junction Shells, Dust Caps, Bonding Rings, Gland Nuts, Clamps, Dummy Receptacles

Featuring High Quality Materials and Workmanship... Junction shells are designed to protect, shield, and carry wires through walls, panels or bulkheads to conduit. Dummy receptacles hold and protect plugs when not in use.

cannon plugs • standard of quality for the industry

TBF-K

For Carrying Circuits Through Bulkheads

TBF-K Bulkhead Connectors... feature a double-faced construction *allowing mating at both ends.* Pin inserts. Single piece shell. Five insert assemblies available.

Other Cannon Series... Mil. Spec. "MS" (full line) – External Power Connectors – Switching Types – dc Solenoids – Guided Missile Launching Connectors – Miniatures and Sub-Miniatures.

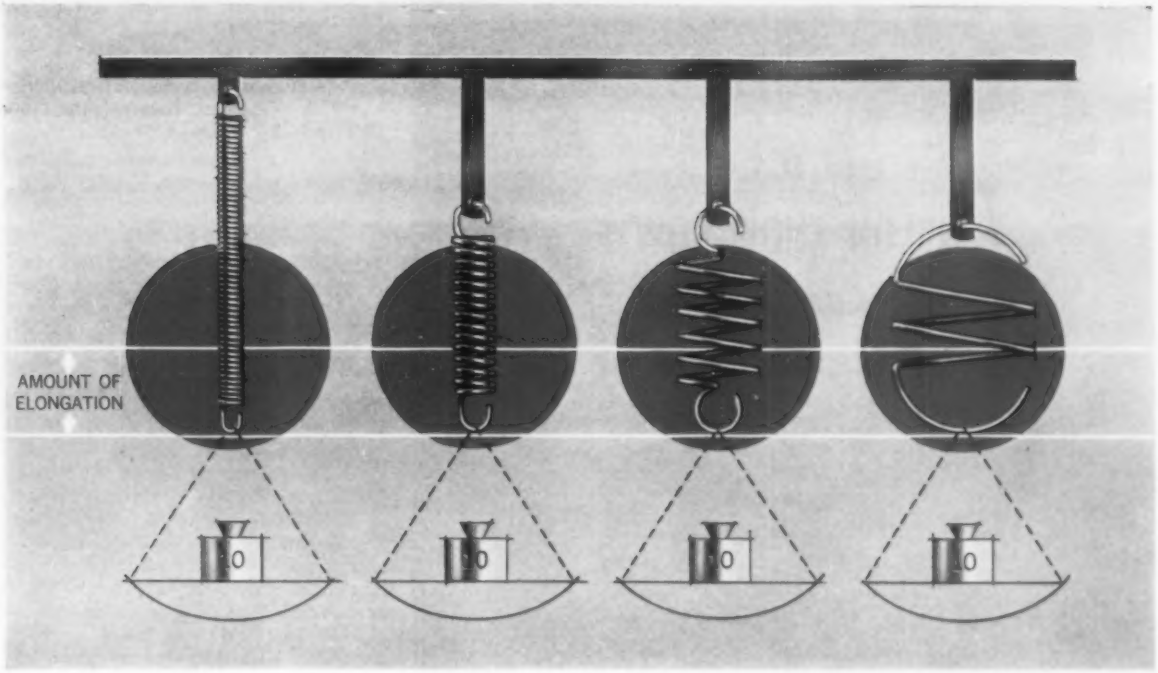
See "K" Bulletin for Engineering Data.

Please Refer to this Magazine or to Dept. 106

CANNON PLUGS

Where Reliability for Your Product Is Our Constant Goal

CANNON ELECTRIC COMPANY, 3208 Humboldt St., Los Angeles 31, California. Factories in Los Angeles; Salem, Massachusetts; Toronto, Canada; London, England; Melbourne, Australia. Manufacturing licensees in Paris, France; Tokyo, Japan. Contact our representatives and distributors in all principal cities. See your Telephone Yellow Book.



Spring shape and performance— or what does Spring Index mean?

One man distributes his 150 lbs. over a lean 6 ft. frame; another packs the same avoirdupois within a stocky 5 ft. 6 in. height. In a man, this might be expressed as the ratio of height to belt size. In a spring, it's a handy little ratio D/d, that of mean coil diameter to wire diameter. The illustration shows it quickly—same load—10 lbs.; same deflection—0.4 in. But in shape they range from the long thin spring at left with 75.8 coils and a spring index of 3, to the short fat spring at right with few coils and an index of 12. Application of the index ratio is particularly useful where space restrictions exist.

Our long years of specialization have developed many short cuts to spring specification to make your work easier. For general reference purposes write for pamphlet "Spring Design and Selection in Brief."

Associated Spring Corporation

General Offices: Bristol, Connecticut

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.
B-G-R Division, Plymouth and Ann Arbor, Mich.
Gibson Division, Chicago 14, Ill.
Milwaukee Division, Milwaukee, Wis.
Raymond Manufacturing Division, Corry, Penna.
Ohio Division, Dayton, Ohio
F. N. Manross and Sons Division, Bristol, Conn.
San Francisco Sales Office, Saratoga, Calif.
Seaboard Pacific Division, Gardena, Calif.
Cleveland Sales Office, Cleveland, Ohio
Dunbar Brothers Division, Bristol, Conn.
Wallace Barnes Steel Division, Bristol, Conn.
Canadian Subsidiary: The Wallace Barnes Co., Ltd., Hamilton, Ontario and Montreal, Quebec

5810

For those mechanical and electro-mechanical parts that must be strong, durable, wear resistant, *design to use Chemiseal Nylon* (du Pont ZYTEL). It has the highest compressive strength, is the most rigid, has the best resistance to heat, abrasion, chemicals, solvents, oils and greases—and is the lowest priced of the standard nylon compositions.

U.S.G. Nylon service goes all the way, offering STOCK (sheets, tape, rod, tubing, special shapes), for manufacture of parts in your own plant; MACHINING (precision fabrication on high speed automatics) to your specifications; and INJECTION MOLDING (volume production to close tolerances at lowest cost).

To be sure you are securing your parts at the lowest cost, consistent with your requirement at every stage from prototype to plant scale production—*check your costs with U.S.G. "know-how"*.

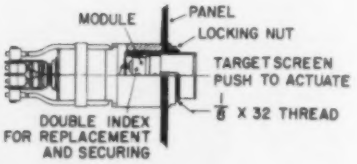
For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses throughout the U.S. and Canada, or write

United States Gasket Company
Camden 1, New Jersey

United States Gasket *Plastics Division of* **GARLOCK**

over-all steel housing, is for equipment converting dc to proportional ac voltage for amplification. **Tracerlab, Inc, 1601 Trapelo Rd, Waltham 54, Mass.**

Circle 24, Reader Service Card



Pushbutton switch . . .

combines monitoring and switching in a modular, dual-purpose unit designed for flush or sub-panel mounting. Monitors three different conditions through a 3-color indicator-light assembly. Lamp circuit can be wired independently or through switching unit. Illumination of each individual lamp passes through colored filter and is projected on target screen. High light intensity permits use with standard ambient room lighting. Unit accepts three 28- or 6-v lamps. Filters are offered in 35 standard colors. DPDT contacts are rated 5 amp, 125 or 250 v ac; 4 amp, 30 v dc resistive; 2.5 amp, 30 v dc inductive. Operating force is 2¼ (±½) lb. Momentary or alternate-action switching elements are standard. Operates in ambient temperatures from —65 to 180 F. Electrical life is said to be 50,000 operations. With bottom or side terminals. Weighs 3½ oz. **Switch Div, Electrosnap Corp, 4230 W Lake St, Chicago 24.**

Circle 25, Reader Service Card

Hydraulic filter . . .

for all types of fluids, lubricants, fire-resistant liquids and coolants. Wire-mesh filtering element in small corrugations with monel support fits into aluminum alloy housing. Filter has capacity of 5, 8 or 10 gpm. Operates in temperatures to 100 F. Recommended for 175 psi. Cleaned by using air, brush or reverse flow of liquid. For pipe sizes ¾ and 1 in. Weighs 4 to 6 lb. **Capital Engineering & Mfg Corp, 5837 S Ashland Ave, Chicago 36.**

Circle 26, Reader Service Card

Fluid power pumps . . .

are offered in two series: 2100 Series in ratings from 16 to 32 gpm at 1800 rpm, operating pressures to 2000 psi and up to 40 gpm at 1500 psi; 3000 K Series in ratings from 24 to 65 gpm at 1200 rpm, for operating pressures to 1500 psi and operating speeds to 2400 rpm. Pumps are

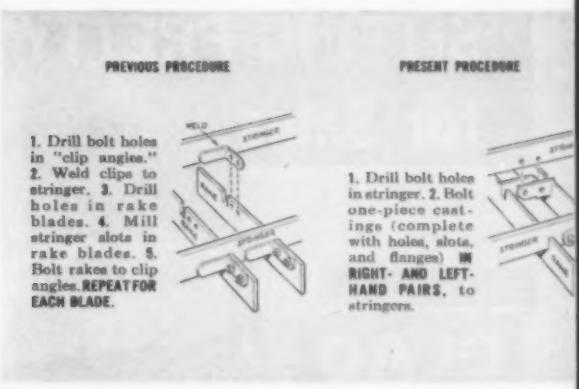
(Continued on page 123)

How to cut costs, improve product design with stainless steel close-tolerance castings

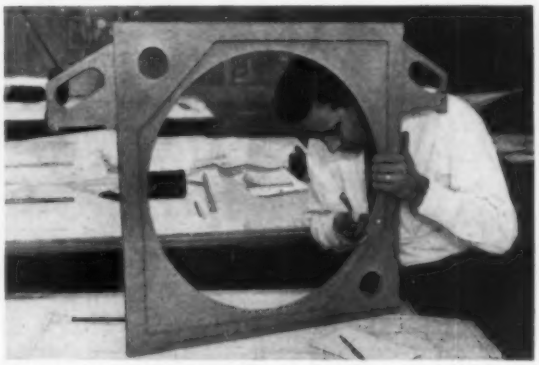
Cooper Alloy design collaboration with advanced casting techniques can simplify your fabrication, cut your costs. Here's how:

Casting of intricate parts: Jet engine afterburner component, cast for Pratt & Whitney Aircraft by Cooper Alloy, is a tangle of projections and cavities. Required, however, were the most precise dimensions to make for automatic precision machining. Shellcast® shell coring and CO_2 process cut down rejection and machining costs.

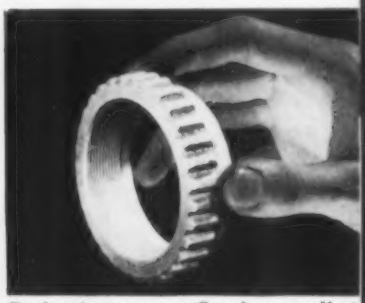
Strength and quality: Castings stronger than forgings! These Cooper Alloy nuclear service fittings possess high-temperature yield strengths 20% higher than minimum code specifications. Tough quality requirements have been met and bettered on a regular repetitive quality basis.


PREVIOUS PROCEDURE
PRESENT PROCEDURE
1. Drill bolt holes in "clip angles." 2. Weld clips to stringer. 3. Drill holes in rake blades. 4. Mill stringer slots in rake blades. 5. Bolt rakes to clip angles. REPEAT FOR EACH BLADE.
1. Drill bolt holes in stringer. 2. Bolt one-piece castings (complete with holes, slots, and flanges) IN RIGHT- AND LEFT-HAND PAIRS, to stringers.

Part redesigned, simplified, assembly costs lowered. Classifier rake blad Shellcast® by Cooper Alloy for Dorr-Oliver Inc., was originally ma by welding cast and machined elements. Close-tolerance, smooth-surfa shell castings made possible design change to one-piece cast un eliminating welding and much of the assembly costs.



Casting of thin-walled close-dimensioned parts. Tennessee Eastman filter frame plate previously required a good deal of careful milling on thin inner web. Combined use of shell core in a sand mold held tolerances, eliminated milling operation.



Product improvement: Gear lugs on adjust ing ring for Manning, Maxwell & Moor pressure safety relief valve, formerly san cast, are now being produced directly b Shellcast® process. Dimensional accuracy possible with shell castings permitted re design of part to give more lugs, fine adjustability in use.

If you haven't looked over your fabrication and assembly costs lately, check the unusual cost-saving techniques listed in the capsule stories shown above. They are typical of Cooper Alloy advanced casting know-how. Many parts and assemblies that you probably haven't even considered as makable by castings, can be now by Cooper Alloy, specialists for over 35 years in casting *only* stainless steel.

Want more information? To learn more of how Cooper Alloy know-how can help cut *your* manufacturing costs, write for our free 16-page booklet, "Cooper Alloy—Pioneering in Stainless Steel." Also available, information on the other problem-solving Cooper Alloy products listed below.

COOPER ALLOY

Corporation • Hillside, New Jersey

SPECIALISTS *in Stainless Steel valves, fittings, castings; Plastic pumps, pipe, valves, fittings*

CIRCLE 173 READER SERVICE CARD

With this NEW FINISH almost any product is "SITTING PRETTY" for Sales

Masland Duran CLAD vinyl finish

MASLAND DURAN CLAD back and seat on chair by AMERICAN SEATING CO. Grand Rapids, Mich.

Cases, housings, cabinets, components . . . and, in fact, just about any manufactured item, is more colorful and salable with Masland Duran Clad. This colorful vinyl can be permanently laminated to metal . . . formed or stamped on your present equipment . . . and crimped, bent, shaped or drilled without impairing its textured finish. Cleans with soap and water. Send coupon for samples and information.

Industrial Products Division

THE MASLAND DURALEATHER CO.

Dept. PE, Philadelphia 34, Pa.

THE MASLAND DURALEATHER CO., Dept. PE
Amber and Willard Sts., Philadelphia 34, Pa.

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CIRCLE 175 READER SERVICE CARD

DIMCO-GRAY *Stock plastic* KNOBS...HANDLES

WRITE FOR THIS COMPLETE CATALOG!

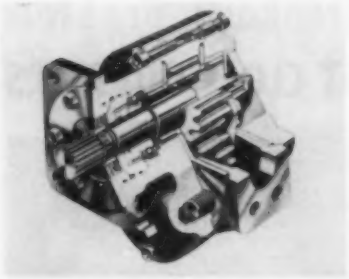
NO TOOL CHARGE!

Wide selection of stock knobs, handles and plastic parts available without tooling cost to you! Many minor changes, (color, design, inserts, threads, special materials, etc.) can be made to meet your requirements.

DIMCO-GRAY COMPANY
206 EAST SIXTH STREET • DAYTON 2, OHIO

CIRCLE 174 READER SERVICE CARD

CIRCLE 176 READER SERVICE CARD



built with 2-stage high-pressure seal. Available with standard flange and shaft or industrial foot mountings. Ports are machined for SAE split-flange connections. **Hydreco Div, New York Air Brake Co, Kalamazoo, Mich.**

Circle 27, Reader Service Card

Die-cut sprockets . . .

for roller chains can be furnished with or without shoulder hubs with from 11 to 80 teeth in various sizes. Plate-type sprocket has flatted hole to receive flatted shoulder hubs. Plate-type sprockets can also be provided with plain round holes in 1020 steel or case-hardened to order. Said to be 50 to 60% cheaper than machine-cut roller chain sprockets. **Dayton Rogers Mfg Co, 2824 13th Ave S, Minneapolis 7.**

Circe 28, Reader Service Card

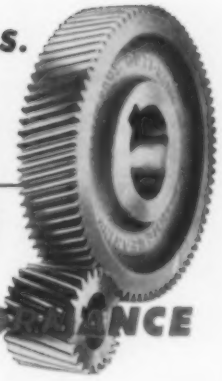
Stepping motors . . .

in three new models, for applications requiring smaller size and/or unidirectional operation, translate pulses into incremental shaft positions and may be used to rotate control mechanisms, potentiometers, counters and rotary switches. A 36° angular increment per pulse gives 10 indexing positions with ½° detent accuracy at max stepping rate of 15 per sec. Motors meet applicable environmental tests of MIL-E-5272A and have ambient temperature range of −67 to 176 F at altitudes to 90,000 ft. Servo or stud mounting and a wide range of operating voltages are available. Series 2 motors, in bidirectional and unidirectional models, have load capacity of .13 in.-oz and a 1.125-in. D frame; Series 3 unidirectional motor (bi-

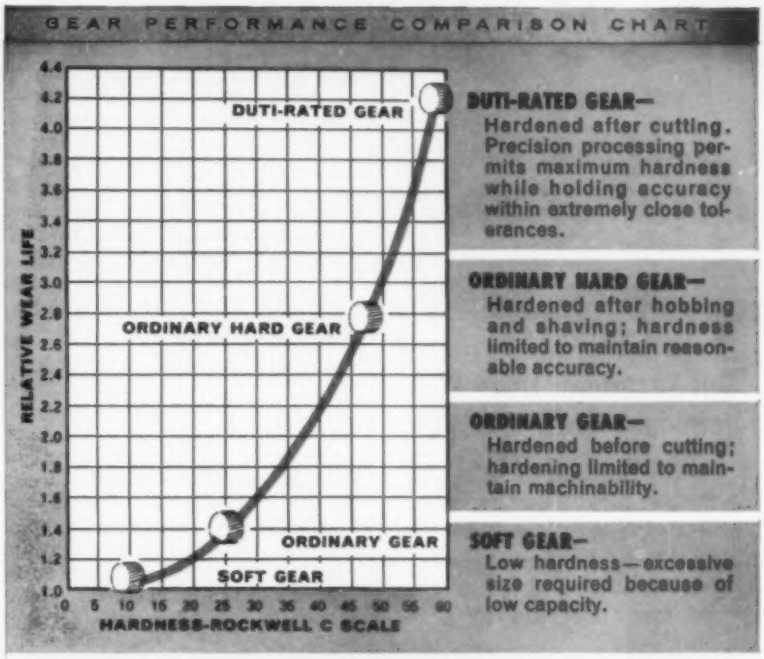
(Continued on page 124)

HERE'S WHY FOOTE BROS.

Duti-Rated LIFETIME GEARING



GIVES BETTER PERFORMANCE ...LONGER LIFE



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See how you can get more for your drive dollar.

this trademark stands for the finest industrial gearing made

T. M. REG. U. S. PAT. OFF.

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Better Power Transmission Through Better Gears

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QUICK DISCONNECT COUPLERS

Self-Sealing or Open Flow
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- ¼" to 2" capacities
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611 So. 9th, Lincoln, Nebraska

Please send me free —
Aircraft Coupler sample.

NAME _____

COMPANY _____

ADDRESS _____

HYDRAULIC, PNEUMATIC AND FUEL SYSTEM COMPONENTS

directional unit was original motor) has load capacity of 2 in.-lb at 68 F and is built on a 1.5-in. D frame. Weights range from 13 oz for the latter unit to 4 oz for unidirectional Series 2 model; lengths in this same order range from 2.525 to 1.331 in. Stock models are available for immediate shipment. **G H Leland Inc, 123 Webster St, Dayton 2.**

Circle 29, Reader Service Card

High-pressure solenoid valve . . .

for controlling air and gases to 2500 psi and liquid to 1800 psi has packless, 2-way construction. Valve body and operating parts are stainless steel. Tight seating on liquids and gases, without closely fitted parts that require constant adjustments. Available with NEMA I, IV or III, IX and IXA solenoid enclosures, ¼ in. NPT or AND connections and standard, threaded or AN electrical connections. **Automatic Switch Co, Florham Park, NJ.**

Circle 30, Reader Service Card

Air-cooled engine . . .

is a short-stroke, 4-cycle unit rated 24 hp at 3200 rpm, for applications requiring heavy starting loads and low power-takeoff speeds. Clutch reduction assembly combines dry clutch equipped with antifriction ball bearings and a chain-drive reduction gear. Power takeoff shaft is mounted on roller bearings. Available in 2:1, 3.25:1 and 3.79:1 reduction ratios. Starting equipment consists of either a crank starter or a 6- or 12-v starter-generator. Engine can also be equipped with housing with fuel tank. **Kohler Co, Kohler, Wis.**

Circle 31, Reader Service Card

Scaled grid templet . . .

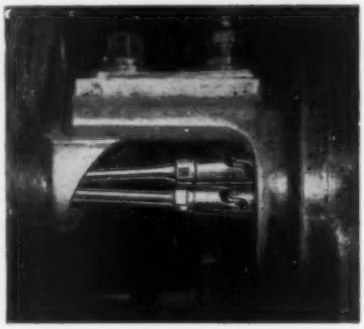
has ¼-in. grid with 17 x 11-in. printed image; trimmed to 19 x 12 in. The 0.005-in. thick mylar-base transparent film is treated to hold dimensional stability. Will not curl, discolor, warp or chip and takes penciling and erasures. Price is $4.95 postpaid. **Check-scale Products Co, PO Box 15781, Los Angeles 15.**

Circle 32, Reader Service Card

Price Correction

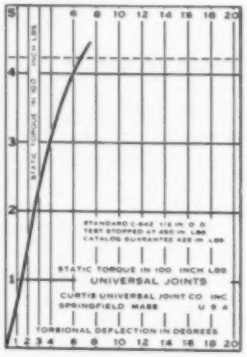
In our issue of Sept 22, p 42, we stated that the electrohydraulic valves produced by Oilgear Co, Milwaukee 4, are available for "less than $55." This was a typographical error. The correct figure should be "less than $500."

Solving a breakage problem AT CLOSE QUARTERS



The manufacturer of this button-drilling machine had a tough problem: the universal joints on these parallel shafts carried such a torque load there were frequent complaints of breakage . . . yet the close centers prohibited use of a larger joint.

THE SOLUTION was a Curtis Universal Joint of the same size.


STATIC TORQUE IN 100 INCH LBS
UNIVERSAL JOINTS
CURTIS UNIVERSAL JOINT CO INC
SPRINGFIELD MASS U S A
TORSIONAL DEFLECTION IN DEGREES

Torque Curve ½" Curtis Universal Joint

This is only one of many problems solved by Curtis Joints — size for size the strongest universal joints designed for industry. Selected materials, precision engineering, and over 30 years' experience manufacturing universal joints make them that way.

14 SIZES ALWAYS IN STOCK —
⅜" to 4" O.D. (6" joints on special order)

Not sold through distributors. Write direct for free engineering data and price list.

TRADE MARK CURTIS

UNIVERSAL JOINT CO., INC.

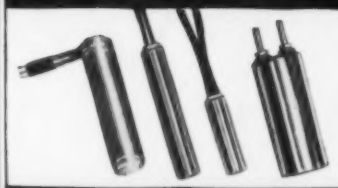
11A Birnie Avenue, Springfield, Mass.

As near to you as your telephone

EXCLUSIVELY A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

Solve Your
HOT PROBLEMS
with

VULCAN VERSATILITY



IN CARTRIDGE HEATERS

Vulcan Electric Cartridge Heaters are especially designed for insertion into machine parts, dies, platens, molds, presses, die blocks of embossing machines, packaging machines, etc.

You have a wide choice of standard sizes — from 1″ to 25″ (or longer); diameter — ¼″ to 1¾″ (or greater); wattage — 10 to 3200 (or higher); voltage — standard 120 or 240, special 6 volts up; sheath — brass, steel, nickel or high temperature alloys; standard or special lead wires or terminals.

When your hot problems call for unusual specifications, you get a speedy solution through *Vulcan Versatility* — in design, engineering and production. Standard or special, Vulcan is ready to supply your complete needs in low cost, efficient heating units. Send coupon for Catalog and prices.

VULCAN

Cartridge • Strip • Tubular • Immersion Electric Heaters • Soldering and Branding Irons Solder and Glue Pots

VULCAN ELECTRIC COMPANY
Danvers 18, Mass.

Please send me catalog and price information on Vulcan Electric Heaters. I am especially interested in (check)

☐ Cartridge ☐ Tubular
☐ Strip ☐ Immersion
☐ Other

NAME & TITLE.....
COMPANY.....
STREET & NO.....
CITY & STATE.....

CIRCLE 180 READER SERVICE CARD

HERE'S WHY P&B's PR POWER RELAY IS PREFERRED

for high current or voltage switching

HEAVY DUTY construction means long-term dependability when switching up to 20 amperes (double break contacts). Here is a ruggedly built, economically-priced relay with many quality features.

The PR's full floating movable contact carrier provides excellent contact pressure and ample wipe for self-cleaning contact action. The PR has been adapted for printed circuitry and heavy duty plug-in applications. Write or call for complete information today.

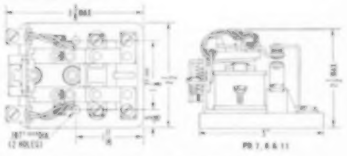
ENGINEERING DATA

GENERAL SPECIFICATIONS:
Breakdown Voltage: 1500 volts rms min. between all elements and ground.
Ambient Temperature: DC: —55° to +85°C. AC: —55° to +55°C.
Terminals: Heavy duty screw type. Standard printed circuit pins or plug-in on request.
Enclosures: PR dust cover.

CONTACTS:
Arrangements: Up to 2 Form C (DPDT).
Material: 5/16″ dia. silver or silver cadmium oxide. (Others available)
Load: Single break: 15 amps; Double break: 20 amps at 115 volts 60 cycle AC resistive.

AUXILIARY CONTACTS
Arrangements: 1 Form A, B or C.
Material: 3/16″ diameter silver
Rating: 5 amps at 115 volts 60 cycle AC resistive.

COILS:
Resistance: 64,000 ohms maximum.
Power: 1.8 watts DC; 9.8 volt-amps AC.
Duty: Continuous AC or DC (DC coils will withstand 10 watts at 25°C).
Insulation: Centrifugally impregnated with high quality varnish.
Mountings: 2 holes .187″ diameter 1⅞″ o.c.



PR Relays Approved By Underwriters' Laboratories & Canadian Standards Association

Type	Contact Arrangement*	Type	Contact Arrangement*
PR1AY	SPST-NO	PR5AY	SPDT
PR2AY	SPST-NC	PR7AY	DPST-NO
PR3AY	SPDT-NO-DM	PR8AY	DPST-NC
PR4AY	SPDT-NC-DB	PR11AY	DPDT

These relays are available in any of the following operating voltages: 6, 12, 24, 48, 115, 208, 230, or 440 volts 50/60 cycles AC.

The contacts are rated at: 13 amps, 115 volts AC. 6.5 amps, 230 volts AC. 1 hp for 115 or 230 volt AC motors. Any relays deviating electrically or physically from these standard models will not carry U/L or CSA approval.

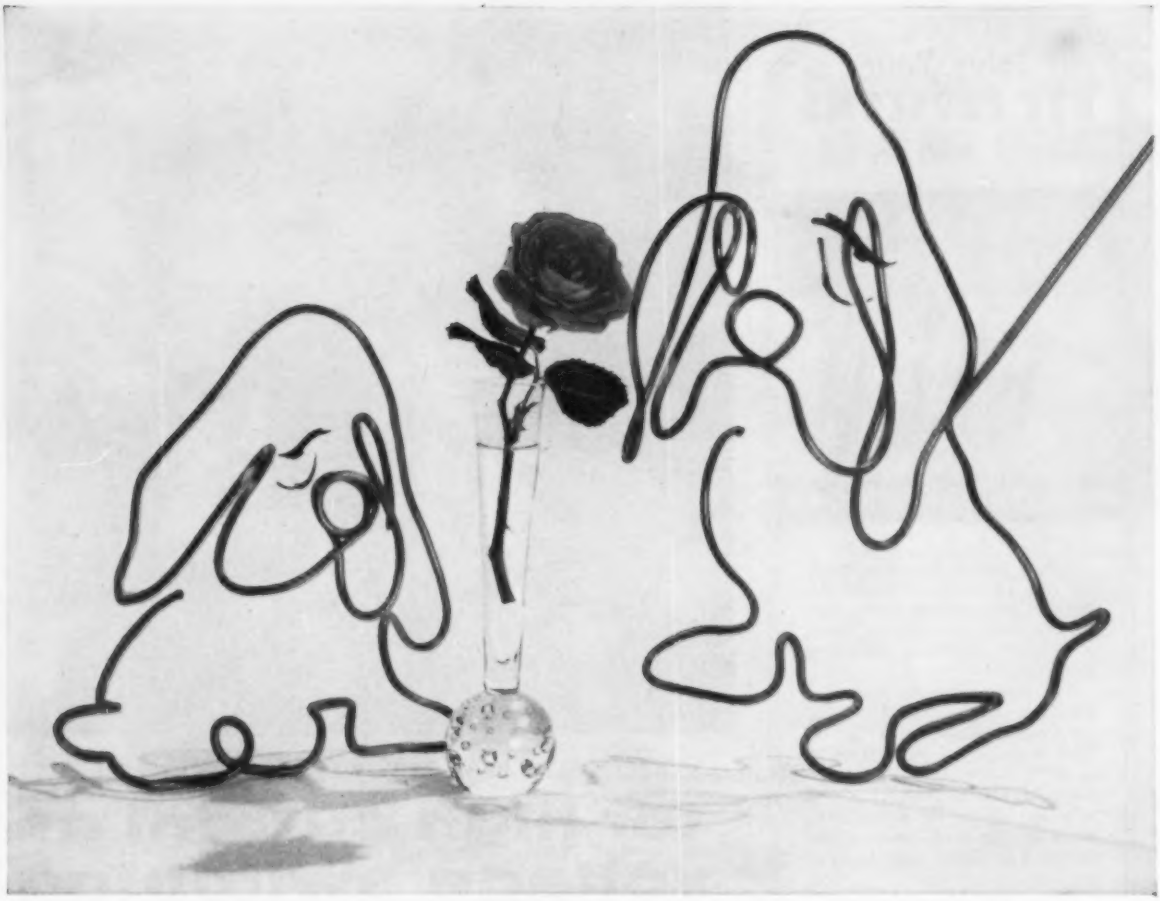
*Read: NO normally open, NC normally closed, DB double break, DM double make.

P & B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD INC.

PRINCETON, INDIANA • SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

CIRCLE 181 READER SERVICE CARD



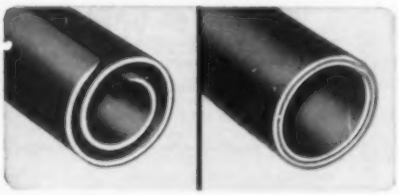
There's practically no limit to the things Bundy can mass-fabricate

. . . and we do it with Bundyweld, the stronger, safer steel tubing that's made for easy bending

SKILLED Bundy® technicians turn out many a strange shape—each to its exact tolerances. At Bundy, you get precision *in mass-fabrication*. Jigs, fixtures—even machines—are designed by Bundy specifically to cut customers' unit costs.

You get Bundyweld® Tubing, too. An exclusive process (right) gives it unique physical properties. So Bundyweld—master of volatile refrigerants and high-pressure brake fluids—has become the safety standard of two major industries.

Bundy engineers will design your tubing part, or work with you on its development. When we fabricate your parts, you can count on careful packaging, on-time delivery. Bring *your* tubing problem to Bundy. Contact us today!



Bundyweld is the only tubing double-walled from a single copper-plated *steel* strip, metallurgically bonded through 360° of wall contact for amazing strength, versatility.

Bundyweld is lightweight, uniformly smooth, easily fabricated. It's remarkably resistant to vibration fatigue; has unusually high bursting strength. Sizes up to ⅜" O.D.

There's no real substitute for Bundyweld Tubing

BUNDY TUBING COMPANY

DETROIT 14, MICHIGAN

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, ENGLAND, FRANCE, GERMANY, AND ITALY

Change motors in minutes—

with FALK *all-steel* MOTOREDUCERS

No long and costly "down time" involved

Motors can be interchanged or replaced *in minutes* with the all-steel, All-Motor type FALK Motoreducer. No long and costly "down time" is involved in making the change!

Best of all, replacement is not limited to original make of motor—new NEMA frames may be substituted for old. This versatile Motoreducer operates with any make, speed or type of standard foot-mounted motor within its AGMA rating. No modification, no special shaft, no "partial" motor required.

In addition to unmatched motor interchangeability, this dependable gear drive—the "work horse of industry"—offers: widest choice of output-shaft position (horizontal, vertical, right-angle)...any output-shaft connection...any mounting, including wall and ceiling...standard speed range from 1.5 rpm to 1430 rpm. All these advantages, plus proved efficiency, low maintenance and extra-long life, make the All-Motor type FALK Motoreducer your best buy for any job requirement.

Furnished in sizes up to 75 hp with any make, style or type of motor; or, *without a motor if desired.* FALK Motoreducers are available from convenient factory, field or distributor stocks, from coast to coast.

Write for Bulletin 3100

THE FALK CORPORATION, MILWAUKEE, WISCONSIN

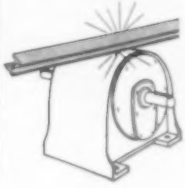
MANUFACTURERS OF:

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

FALK

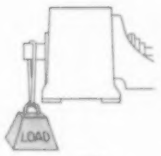
...a good name in industry

FALK "IN-BUILT" FACTORS assure full dependability—better service—longer life



ALL-STEEL HOUSINGS

Rugged, strong, rigid ...all parts heavy steel plate, formed and welded in the Falk Weld Shop.

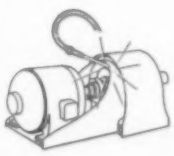


LARGE OVERHUNG LOAD CAPACITY

Large shafts, oversize bearings...rigid mountings with wide bearing spans to handle maximum loads.

PRECISION GEARING

Heat-treated alloy steel gearing, precision cut and shaved after heat treatment to eliminate distortion.



SEALED HOUSINGS

Splashproof, dustproof, oiltight. Dual closures and one-way vents keep oil in, dust and moisture out.

CIRCLE 183 READER SERVICE CARD

ESSEX ENGINEERED

APPLIANCE WIRE AND CABLE

Approved by CSA — Bears UL Label

HERE'S HOW ESSEX CAN GIVE YOU A HELPING HAND AND PROBABLY SAVE YOU SOME MONEY, TOO!

1. COMPLETE LINE

THE FULL ESSEX LINE OF APPLIANCE WIRING MATERIAL... THERMOPLASTIC, RUBBER, NEOPRENE AND SILICONE LEAD WIRE, PLUS INTERNAL REFRIGERATION AND AIR CONDITIONING WIRES, POWER SUPPLY CORDS AND HEATER WIRE...QUICKLY AND ECONOMICALLY MEETS MOST WIRING REQUIREMENTS.

2. APPLICATION ASSISTANCE

OUT-OF-THE-ORDINARY WIRE OR CABLE SPECIFICATIONS NEED NOT TROUBLE YOU. CONSULT YOUR LOCAL ESSEX APPLICATION ENGINEER FOR THE SOLUTION-OR FOR HELP IN CHOOSING THE ONE BEST TYPE AND SIZE FOR ANY APPLICATION.

OTHER ESSEX ENGINEERED WIRE AND CABLE

SUBMERSIBLE CABLE—Waterproof motor lead wires and drop cables with watertight molded connections.

MOTOPRENE® AUTOMOTIVE CABLE—Thermoplastic..brake cable..rubber covered cord.

MOTOR LEAD WIRE—Rubber, Neoprene or Thermoplastic insulation.

Consult your local Essex Application Engineer or write for complete information

WIRE SX PRODUCTS®

ESSEX WIRE CORPORATION
Wire and Cable Division
FORT WAYNE 6, INDIANA

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 134.

COMPRESSION PACKINGS–Catalog, 20 pp. Presents line of sheet and rod seal packings, describes characteristics and illustrates applications. Ordering data includes recommended packing chart, properties and weight information. E F Houghton & Co, 303 W Lehigh Ave, Philadelphia 33.

Circle 33, Reader Service Card

WROUGHT ALUMINUM-MAGNESIUM ALLOYS–Technical paper 14, 64 pp. Reviews metallurgy of aluminum-magnesium alloys and effect of magnesium, manganese and chromium contents on mechanical properties and characteristics of these alloys. Describes mechanism of stress corrosion of metals, test methods employed in research and results of tests. Includes property tables, bibliography. Summary of talk by E. H. Dix Jr, Asst Director of Research, Aluminum Co of America, Pittsburgh.

Circle 34, Reader Service Card

GEAR REDUCERS–Catalog 5802, 48 pp. Contains engineering and selection data on parallel-shaft gear reducers in ratios to 10,000 hp. Gives service factors, mechanical hp ratings, thermal hp ratings, dimensions, overhung load capacity. Illustrated with dimensional drawings, photos and schematics. Western Gear Corp, PO Box 182, Lynwood, Calif.

Circle 35, Reader Service Card

RELAYS–Catalog 159, 20 pp. Includes illustrations, specs and dimensional diagrams of latest developments in microminiature rotary relays and sensitive telephone-type relays. Also describes various other relays, enclosures, removable dust covers and observation-window enclosures. Address is: Magnecraft Electric Co, Ph3350Y W Grand Ave, Chicago 51.

Circle 36, Reader Service Card

METAL-CLAD SWITCHGEAR–Bulletin GEA-5664E, 40 pp. Information on operation, characteristics and application of indoor and outdoor switchgear for 2.4 to 13.8 kv with interrupting capacities of 75 to 1000 mva. Includes equipment and application photos, dimensional drawings, spec tables and equipment diagrams. General Electric Co, Schenectady 5.

Circle 37, Reader Service Card

SHAFT-MOUNTED SPEED REDUCERS–Brochure 2618, 24 pp. Describes construction (with exploded-view photo); discusses selection (includes selection tables); gives dimensions (with dimensional drawings), mounting and assembly data (with diagrams) and tables of sheave and V-belt combinations. Link-Belt Co, Dept PR, Prudential Plaza, Chicago 1.

Circle 38, Reader Service Card

MAGNESIUM IN ELECTRONICS–Booklet, 20 pp. Discusses properties that make it a useful metal in airborne and air-transportable electronics equipment, and shows pictorially where magnesium is being used in electronics today. Magnesium Dept, Dow Chemical Co, Midland, Mich.

Circle 39, Reader Service Card

ROTATING MECHANICAL SEAL–Bulletin AD-164, 8 pp. Lists types, optional designs, specs and installations of corrosion-resistant seal. With cutaway and dimensional drawings and schematics. Garlock Packing Co, 427 Main St., Palmyra, NY.

Circle 40, Reader Service Card

HOLLOW ALUMINUM BAR STOCK–Brochure, 8 pp. Lists standard sizes with wall thicknesses, dimensions, weight per foot. Also: tolerances, alloys, mechanical properties and specs of the hollow machining material. Harvey Aluminum, 19200 S Western Ave, Torrance, Calif.

Circle 41, Reader Service Card

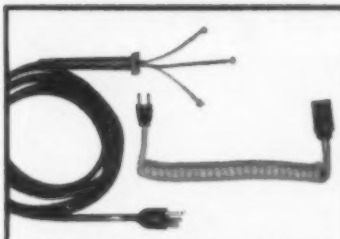
GEARSHIFT DRIVES–Bulletin, 8 pp. Describes construction and typical applications of drive, which is a combination of a 4-speed sliding gear transmission and a heavy-duty induction motor. Gives comparative data on this and other types of drives. Lima Electric Motor Co Inc, Dept 145, Lima, Ohio.

Circle 42, Reader Service Card

LEVEL CONTROLLER–Bulletin RF-587, 4 pp. Describes construction, operation and application of pneumatic-electronic control device that detects and controls changes in media level. With schematics, installation drawings and

(Continued on page 130)

They can be your design assistants on other Essex Engineered Products.

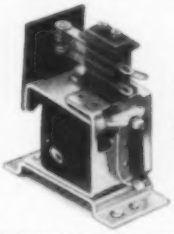


COILED CORDS-CORD SETS

Prime source for plastic and rubber power supply cords. Terminations of all types (molded plastic and rubber) with infinite design possibilities. Complete line of Coiled Cords including HPN.

Write for Coil Cords Literature

Cords Limited Division, DeKalb, Ill.

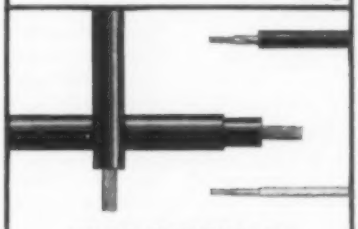


GENERAL PURPOSE RELAY

The basic relay and numerous contact forms, ratings and terminals variations are regular production items...have been "customerized" to solve almost every conceivable problem. Such versatility permits engineering short-cuts that lower your "back door" cost.

Write for Bulletin 1060

R-B-M Control Div., Logansport, Ind.



WIRE AND CABLE

A complete line of appliance wiring material, radio, television and electronic hook-up wire, 200° C high temperature Sil-X wire, automotive wires and cables, and flexible cords.

Wire and Cable Div., Ft. Wayne, Ind.

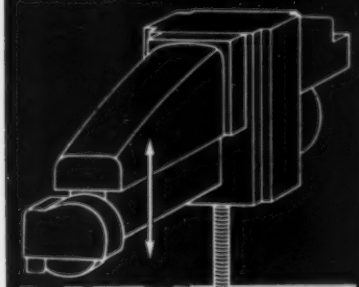
WIRE PRODUCTS

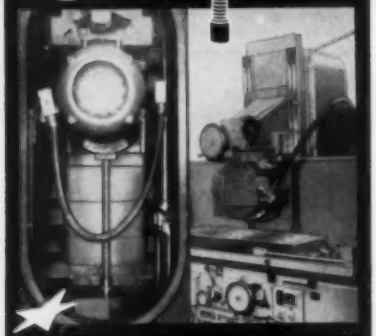
ESSEX

WIRE CORPORATION

OPA

Gallmeyer & Livingston got it when they changed to a Beaver Ball Screw!





Optimum Positioning Accuracy with system stiffness in the head slide of their Model F surface grinder was the design objective of Gallmeyer & Livingston engineers when they changed from an acme to a ball screw — The other advantages they gained were bonuses!

Does your product require precise control of very small increments of motion? Make use of our extensive engineering and application experience. Write for free catalog.

Beaver Precision Products INC.
CLAWSON, MICH.

photos. Robertshaw-Fulton Controls Co, Aeronautical & Instrument Div, 401 N Manchester, Anaheim, Calif.

Circle 43, Reader Service Card

SPECIAL-PURPOSE AIR-MOVING UNITS—Bulletin 5412, 16 pp. Describes and illustrates more than 50 packaged designs. In each case, specs include capacity range, operating speed, construction features and typical applications. American-Standard, American Blower Div, Detroit 32.

Circle 44, Reader Service Card

NICKEL AND NICKEL ALLOYS—Stock list, 12 pp. Stock sizes of sheet, rod, pipe, tube, wire, bar, and angle in nickel, monel, Inconel, and Incoloy now available. Whitehead Metal Products Co, Inc, 303 W 10th St, New York 14.

Circle 45, Reader Service Card

STATIONARY BATTERIES—Bulletin 6205, 8 pp. Explains and illustrates design improvements in product with text, photos and cutaway views. Plate construction is shown. Exide Industrial Div, Electric Storage Battery Co, PO Box 8109, Philadelphia 1.

Circle 46, Reader Service Card

PHASE GENERATORS—Bulletin, 8 pp. Discusses shifter theory and applications. Features, characteristics and performance specs are given. With circuit diagrams for various applications. Theta Instrument Corp, 48 Pine St, East Paterson, NJ.

Circle 47, Reader Service Card

OIL-FILLED POTENTIOMETERS—Data sheet 1482, 7 pp. Describes three models. Gives power-input charts, electrical and mechanical specs, standard coil data and a list of available modifications. Helipot Technical Information Service, Div of Beckman Instruments Inc, Fullerton, Calif.

Circle 48, Reader Service Card

VALVES FOR INSTRUMENT PIPING—Data sheet 302, 4 pp. Gives features, application information, pressure-temperature ratings and specs of valves for instrument and general use. Contains illustrations, sectional drawings. Jerguson Gage & Valve Co, 80 Adams St, Burlington, Mass.

Circle 49, Reader Service Card

MINIATURE DELAY LINES—Bulletin 78, 2 pp. General characteristics and electrical specs for delay lines. Columbia Technical Corp, 61-02 31st Ave, Woodside 77, NY.

Circle 50, Reader Service Card

TRANSISTOR-EQUIPPED TIME-DELAY RELAYS—Engineering bulletin 0558,

(Continued on page 132)

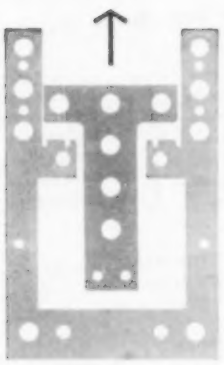
BEAVER BALL SCREWS

Successor to the Acme screw drive and preferred in many applications to hydraulic and pneumatic systems. Guaranteed 90% efficient in converting rotary twist to linear push (or vice versa). Employs a stream of precision balls and ground lead to eliminate drag and wear in delicate instruments, aircraft, machine tools, massive wind tunnel jacks, etc. For horizontal and vertical actions, indexing, inching and traversing. Consultation and engineering service available. Write for literature.

• EXTREME ACCURATE POSITIONING • NO BACKLASH • RAPID START • ANY DIAMETER OR TRAVEL •

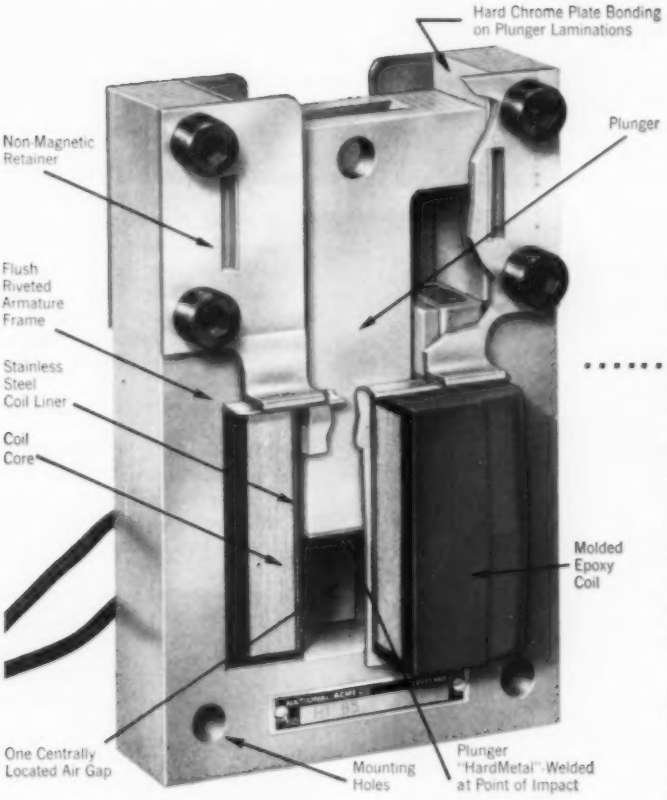
Beaver Precision Products INC.
CLAWSON, MICH.

SOLENOID CHATTER ELIMINATED.....



.....

with the NEW NAMCO "Hard Metal"-Welded Solenoid



.....so quiet in its closed position, so rugged, so adaptable to any design problem, your application headaches are reduced to mere details!

Its noiseless operation permits solenoid applications never before considered practical. The usual chatter and clatter in the closed position is eliminated by a unique design that provides a positive three-point contact in the "holding position." Add to this Namco's exclusive "hard metal"-welded plunger bonding that prevents mushrooming at the vital point of contact; hard chrome-plated upper guide edges of plunger laminations that reduce friction and wear; superior electromagnetic qualities, and the result is a *silent performer* you can't afford to overlook.

Namco standard solenoids are available in a wide range of pull and push types with capacities up to 25 lbs.; custom-engineered solenoids in every size capacity and type can be made to meet your specifications. Write us about *your* application problems stating specific requirements.

National Acme

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170 East 131st Street
Cleveland 8, Ohio

Sales Offices: Newark 2, N. J., Chicago 6, Ill., Detroit 27, Mich.

Micro-Processed Compression Springs
For long spring life and reduced spring cost
I-S Beryllium Copper compression springs are hardened after forming to a tensile strength of 185,000 to 220,000 psi. The resultant springs offer you many advantages . . .
high strength
high conductivity
uniformity
reduced set and drift
close tolerances
long endurance life
resistance of corrosion
stability at elevated temperatures
reduced inspection and assembly costs
less space required of springs
I-S Micro-Processed beryllium copper compression springs are the ideal springs for many applications . . . for pumps and valves — instruments and meters — relays — motor brushes — switches and many others.
Engineer's Assortment . . .
100 Micro-Processed beryllium copper helical compression springs—50 pairs—all different. Write for Bulletin No. 97-44—to help save time and money on development work.
Instrument Specialties Co Inc.
234 BERGEN BLVD., LITTLE FALLS, NEW JERSEY
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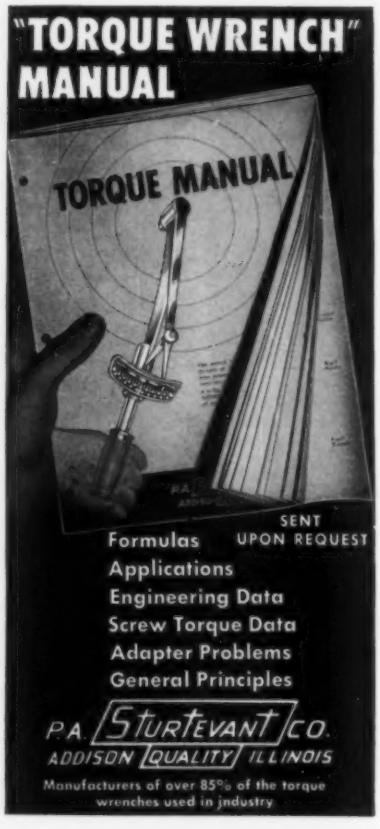
CIRCLE 188 READER SERVICE CARD



CIRCLE 189 READER SERVICE CARD CIRCLE 190 READER SERVICE CARD

Catalogs and Bulletins . . . . . continued

2 pp. Describes subminiature relays. Includes electronic and mechanical design data, voltage and temperature performance curves, specs, mounting styles, dimensions and ordering information. Temp Instrument, Inc, PO Box 338, Hicksville, NY.

Circle 51, Reader Service Card

COLD-DRAWN SEAMLESS STEEL TUBING—Report, 7 pp. Relative cost of tubing and bar stock is subject of study conducted by this company. Charts accompany report. Michigan Seamless Tube Co, South Lyon, Mich.

Circle 52, Reader Service Card

MAGNETIC RUBBER—Bulletin 58, 4 pp. Describes material, gives basic characteristics and properties, illustrates typical applications. Denman Rubber Mfg. Co, Warren, Ohio.

Circle 53, Reader Service Card

CAPTIVE NUTS AND STUDS—Bulletin 58-2, 4 pp. Describes steel-threaded inserts for use in aluminum or brass. With drawings and sketches. National Co Inc, Malden 48, Mass.

Circle 54, Reader Service Card

AIRCRAFT ROTARY ACTUATORS—Bulletin MR-58, 4 pp. Covers 40 packages made up from 12 standard modular components. Describes operation; gives specs, dimensional data, wiring diagrams and a performance range curve. Typical speed-torque performance curves for ac and dc units are also included. Airborne Accessories Corp, 1414 Chestnut Ave, Hillside 5, NJ.

Circle 55, Reader Service Card

HIGH-POWER AC SOLENOIDS—Folder, 4 pp. Describes units, gives specs and pull curves for all models. With dimensional drawings. B/W Controller Corp, 2200 E Maple Rd, Birmingham, Mich.

Circle 56, Reader Service Card

FLOW SWITCH—Bulletin FS-1, 4 pp. Covers line of devices that respond to flow of liquid in a pipeline to make or break an electrical circuit, for pressures to 100 psi. Construction details, dimensions, models available and UL electrical ratings are given. Includes flow diagram from an actual installation. McDonnell & Miller, Inc, 3500 N Spaulding Ave, Chicago 18.

Circle 57, Reader Service Card

MINIATURE SELECTOR SWITCH—Bulletins 558S2 and 558ST2, 2 pp each. First sheet gives features, characteristics, dimensions and environmental specs. Second sheet exclusively covers 4-wafer design, a stock item, and supplements first bulletin with characteristics, dimen-

(Continued on page 134)

IBM KINGSTON

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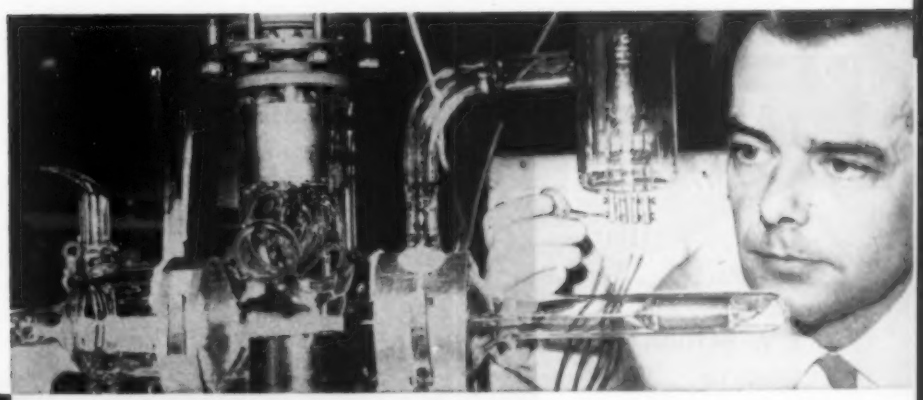

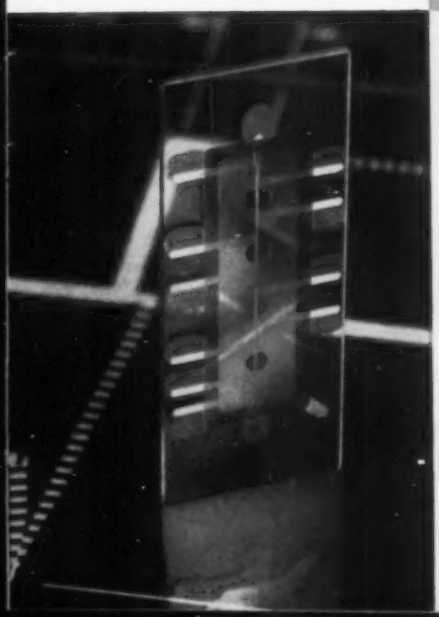

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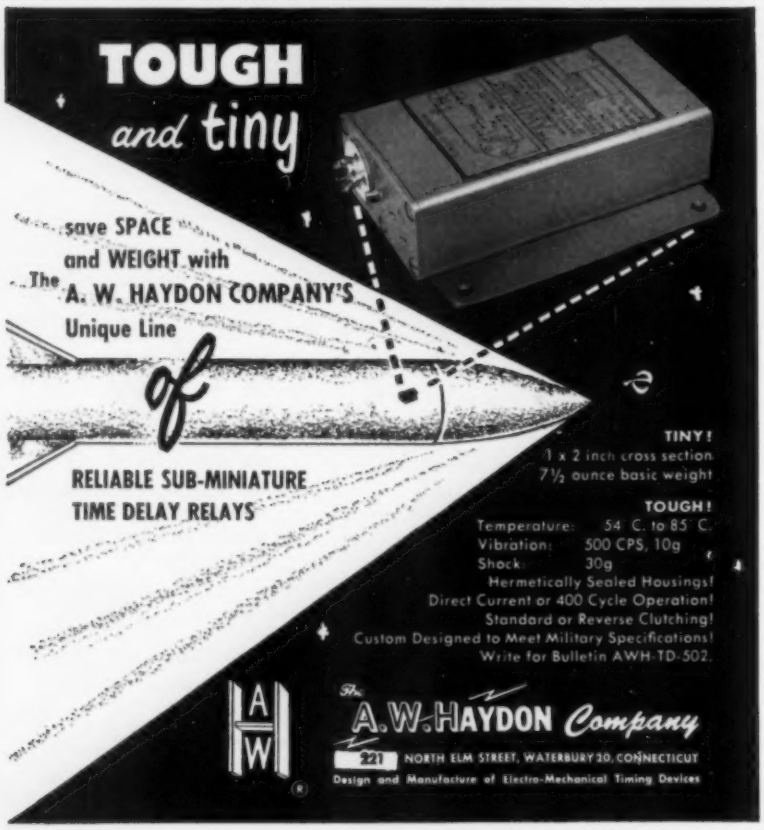

Catalogs and Bulletins.....continued

sional drawings and wiring chart. G. H. Leland Inc, 123 Webster St, Dayton 2.

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DUAL PRESET COUNTER-CONTROLLERS—Technical folder 320, 4 pp. Includes specs, typical applications, construction and basic design data, operational information and suitable diagrams. Computer Measurements Corp, 5528 Vineland Ave, N Hollywood, Calif.

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SEMICONDUCTOR PRODUCTS—Folder, 4 pp. Basic specs for diodes, rectifiers, capacitors and transistors for military and commercial installations. Hughes Products, Hughes Aircraft Co, International Airport Station, Los Angeles 45.

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VARIABLE-DISPLACEMENT GEAR PUMP—Folder, 4 pp. Description of operation is supplemented with 3-color schematic drawings. Lists advantages and suggested applications. Pesco Products Div, Borg-Warner Corp, Bedford, Ohio.

Circle 61, Reader Service Card

WIRE BUNDLING—Time-study report summary, 4 pp. Describes a series of assembly tests conducted by an independent management consulting firm and gives conclusions on time and materials costs and performance of wiring system. Electrovert Inc, 124 E 40th St, New York 16.

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ALUMINUM STUD CAP—Catalog sheets 8-437 and 8-437A, 2 pp. Contains installation sequence photos, sectional and dimensional drawings. Companion sheet presents test report data. Huck Mfg Co, 2480 Bellevue Ave, Detroit 7.

Circle 63, Reader Service Card

SUBMINIATURE INDICATOR LIGHTS—Catalog A-58, 4 pp. Describes line of lights and accessories. Gives dimensions, installation data, wiring details, lamp information. Includes cutaway view of indicator lights and dimensional drawings. Sloan Co, 4101 Burbank Blvd, Burbank, Calif.

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Letterhead Requests Only

Manufacturers who published following literature asked that requests for copies be made on company letterheads.

LOW-FLOW SERVOVALVES—Catalog 210, 6 pp. Curves and schematics indicate design and performance characteristics. Includes glossary of servovalve terms and cutaway photo of a typical valve in this series. Moog Valve Co, East Aurora, NY.

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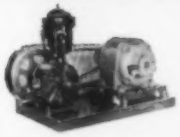

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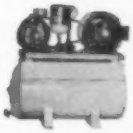
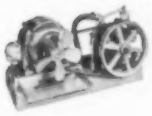
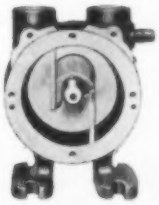




4-WING TYPE. Vacuums to 20" Hg.; pressures to 15 psig.; volume to 162 cfm. Cast iron wings, hinged to pistons, maintain continuous sealed contact with the cast iron cylinder walls by centrifugal force.



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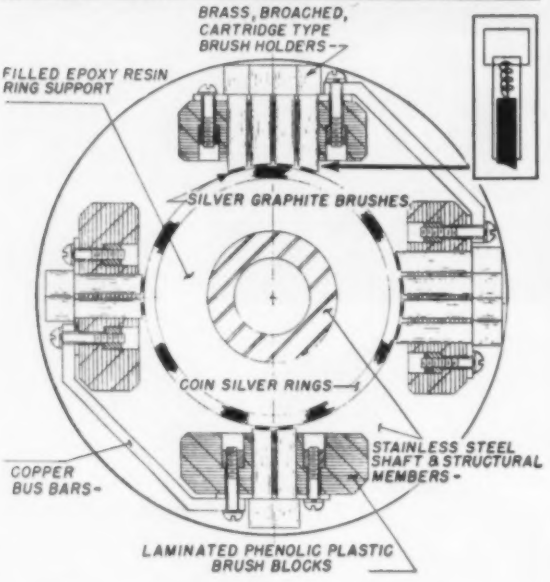
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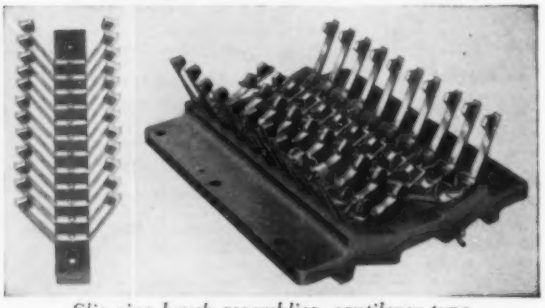

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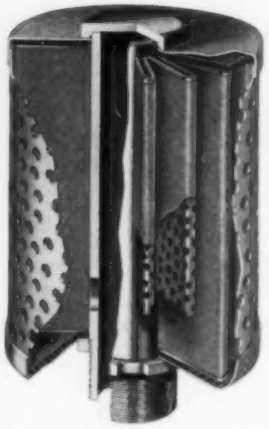

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Tangents...

Reading Should Be A Disease

Elmo Roper, in a speech to the American Booksellers Assn recently, made several interesting points about the American tendency to let books strictly alone (adults currently reading books: US 17%, Canada 31%, Australia 33%, West Germany 34%, England 55%, according to a poll).

It's not a matter of inability to read –it's a matter of lack of desire. Mr. Roper calls reading "intellectually taxing," and book owning a "social deviation." There isn't the folk status in reading that there is in baseball, nor the glamor in owning a book that there is in owning a catcher's mitt. And there is no acceptable disinterested or grass-roots sponsoring organization to develop the interest in reading good books. There's no book-reading equivalent of a bowling or bridge club for adults.

There is, in fact, just the opposite –a tendency to sneer at anyone who reads. A Rochester, NY, optician advertises, for example, that unless a child's nearsightedness is corrected with glasses, "he could easily develop an inferiority complex and turn to books instead of healthy outdoor play."

No word here of the danger of a healthy kid exercising only his muscles and not his brain, nor of the kids without inferiority complexes who read books. Nor even of the doctors who check both types, and who must read books if they are to keep up. Somehow, doctors are expected to read books. No mention either of the men who developed an even more important kind of vision–insight–by reading books when they were young. No mention of Jefferson, Lincoln (who walked miles to borrow books), Franklin, Edison, and a host of other voracious readers.

Time was in the United States when a book was a cherished possession–and not just to lift the youngest to table level. Many men couldn't read then at all–so they envied and admired those who could.

But then we were launched into the bustle of mass production, and life assumed a faster tempo. About the same time, everybody had to go to school–and school became a popular target. From somewhere in the rush, the sentiment grew that reading wasted time, that it was synonymous with softness–even that book knowledge was the refuge of the half man.

It is difficult to determine how this concept arose, and the concept was shaken periodically by an obviously robust he-man who dared to brag that he read–Theodore Roosevelt, Gene Tunney, several baseball and football stars. Some–oh, horrors–even wrote books, but these were excused on the basis that the books were not very deep and that they were actually written by ghost-writers.

The current American cry is that there's too much to read–that we're drowning in a sea of paper. But those who cry loudest are those who actually read least. They have so little practice at understanding the printed word–and often so little skill at scanning it–that they cannot discriminate. They're out of practice in reading–if they ever really learned. They plod through something light as they should plod through something worthwhile, and bog down completely on anything heavy or really thought-provoking. And they cannot bring themselves to discard the frivolous, the useless, the unwanted, and thus conserve their time.

These are often the men, also, who work out ingenious devices to get others to do their reading–or at least to sort it out. They want digests, hot tips, nuggets, visual aids, condensations–but never come back for details. They delude themselves with protestations of their lack of reading time, but have plenty of time for TV, games, and similar activities which are "relaxing." Said our former foot doctor, "ever since we got TV I haven't cracked a book." We changed doctors.

Perhaps no aphorism ever coined is more pernicious than "All work and no play makes Jack a dull boy." It is interpreted to excuse high proportions of play, and every man's name becomes Jack. No notice is taken of the obvious inference in that phrase "*all* work" that a little play is enough to sharpen the dull spots.

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(Continued on page 141)

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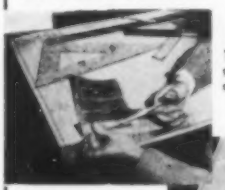

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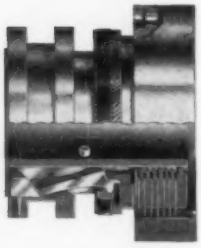

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SPECIFICATIONS:

Model:

Regulator—¼" dome loaded pneumatic pressure reducer

Remote Control type 24 V. D. C. Solenoid operated

Pressure Characteristics:

Inlet, outlet, and gage ports per MS 33656-4

Inlet pressure range—30 p.s.i.g. to 6000 p.s.i.g.

Proof pressure—9000 p.s.i.g.

Burst pressure—15,000 p.s.i.g.

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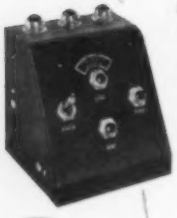
Burst pressure—12,000 p.s.i.g.

Rated Capacity 0.1 (SCFM/PSIA) min. (as defined in MIL-R 8572A)



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	1/8	2100	1840	3690
	5/32	3000	2880	5720
	3/16	4400	4140	8240
	1/4	7700	7360	14720
	5/16	11500	11500	22960
	3/8	17600	16580	33160
	7/16	20000	22540	45000
	1/2	25800	29440	58900

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play that the whole personality becomes dull. This perhaps accounts for the inability of many men to talk in company—beyond a joke or two or a salty reminiscence.

Perhaps we should make books contraband—hard to get. (The price structure for this is already available.) Such a prohibition era might develop bookleggers and revivify the art of social reading. It might even awaken an interest in select and secret reading of "good stuff," as well as morning-after bragging. And the "head" a man gets from reading may even prove pleasurable.

Unfortunately, the figures I quoted originally by country are borne out in contact with their nationals. The American tends to be tongue-tied when he departs from discussion of day-to-day business. And he goes on to hunt a fall guy—which currently is our educational system. It is convenient to lay the blame for personal shortcomings on some inanimate creature that cannot hit back. It is convenient, too, to bluster.

The basic weakness is, however, that bluster is like poor paint—it only covers temporarily. Sooner or later, there'll be a rainy day, and the paint washes away.

All this is, I am sure, not going to send the nonreader back to his books, but then he will not have read this far anyway. Perhaps the only recourse is to get some competent medical body to report that reading books causes some deadly–but socially acceptable–ailment. Then we'll have the greatest rush back to books since Sputnik I.–EJT

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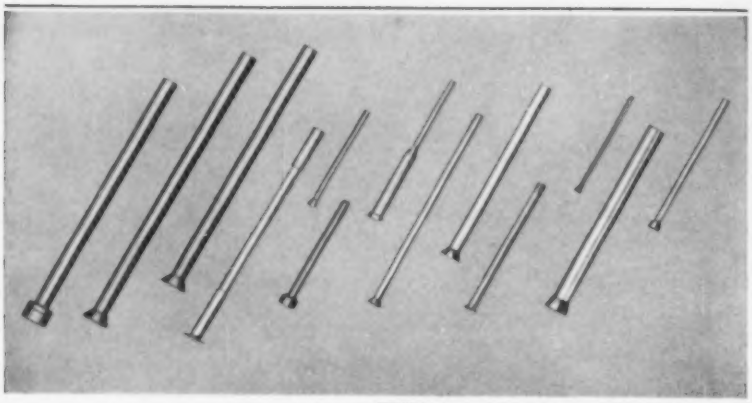
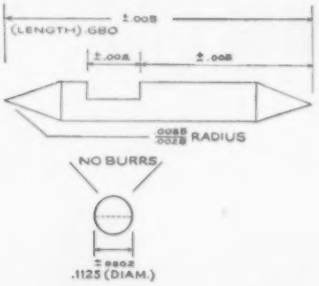
NEWS
from Torrington on
SMALL PRECISION METAL PARTS



Here at Torrington, our "Specialties" machines are constantly at work producing an endless variety of custom-built small precision metal parts. Our engineers help design many of these parts, at the same time developing the most efficient production methods to solve our customers' problems.

For example, one manufacturer recently needed perforating punches with an upset head (see photo above). His own facilities were inadequate for the job . . . specifications called for close body tolerance, grinding, precision heading, hardening and annealing. The punches were to be made from tool steel and produced without flash to allow proper seating. Torrington engineering and production facilities solved his problem.

Another—the volume production of timer parts with low cost a critical factor.



For this job, Torrington developed special high-speed equipment to provide automatic end turning and cross milling in a single operation. The result—a high-quality part produced at low unit cost.

Whatever the part, varying degrees of strength, ductility, hardness, toughness, magnetic or nonmagnetic properties are required to give it the exact qualities needed for its particular function. In Torrington's modern laboratories, highly

experienced metallurgists and engineers are employed to insure that each precision metal part is produced by the most efficient process and to the highest standards required for its application. They'll be glad to help you on all metallurgical problems.

If you have problems involving custom-built small precision metal parts in large quantities, write direct to

The Torrington Company, Specialties Division, 230 Field Street, Torrington, Conn.

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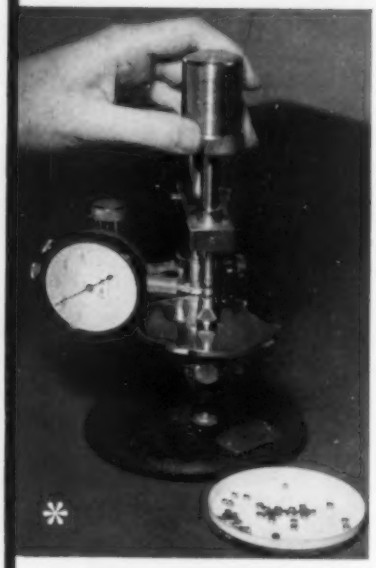
Makers of Torrington Needle Bearings

There's a *Bird* JEWEL BEARING to fit Your Need!



Bird can supply you with sapphire and borrosilicate glass precision jewel bearings in a wide range of standard types, sizes, and complete assemblies — or, custom-built to your specifications. Special mounting techniques provide exact tolerance jewel assemblies, mounted or set in bushings or screws, ready for assembling into your product without further inspection. Jewels mounted with resilient silicone rubber or spring cushions provide additional protection to shock and vibration.

Because of the exact tolerances, maintained through the most rigid quality-control methods, Bird jewels are used by the foremost manufacturers of electrical, aircraft, and timing instruments — and recorders.

Typical products include:

Aircraft Instruments
Weather Recorders
Ammeters
Voltmeters
Wattmeters
Compasses
Dial Gages
Timers
Test & Recording Instruments
Marine Instruments

**Illustrated — Concentricity check of mounted ring jewels — one of the inspection processes in Bird's quality control program.*

Our engineering staff is at your service for all small bearing problems. A request on your letterhead for Bulletin 100-6 will receive our prompt attention.

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PRECISION GLASS GRINDING
JEWEL MOUNTING & ASSEMBLY

DESIGN ABSTRACTS

Organized Plant Lubrication

Reasons for a planned, plant-wide lubricating system and schedule are reviewed. Necessary management steps and required personnel are discussed. Survey of equipment needs, required lubricants, methods and apparatus for application, both manual and automatics, are described.

"Organized Plant Lubrication," Lubrication, July '58; Texas Co, 135 E 42nd St, New York 17.

Designing Stiffness into Plastics Structures

Relatively low elastic moduli of plastics and disadvantages they entail in design are discussed. How moldability of stiffening elements can overcome such problems is described. Several approaches to designing for stiffness are detailed and calculations are provided of the strength of such elements as laminations, ribs, corrugations, curved sections, T-beams, honeycomb, foam panels and various cellular structures.

"Designing Stiffness into Plastics Structures," Sidney Levy, Modern Plastics, Sept '58, 575 Madison Ave, New York 22.

Corrosion-testing Methods

Principal methods of corrosion testing are described and their limitations as a means of obtaining data on engineering materials discussed. The lack of a variety of methods for securing results quickly is noted. Critical influence of preparation of samples and test procedures is discussed.

"Corrosion Testing as an Engineering Auxiliary," D. J. Fishlock, Mechanical World and Engineering Record, Aug '58, 31 King St, W, Manchester 3, England.

Design for Welding

The three predominant undesirable approaches to designing for welding are discussed: (1) attempting to maintain traditional physical structure as developed through previous fabricating procedures; (2) designing extremely lightweight structures without adequate precautions against

(Continued on page 145)

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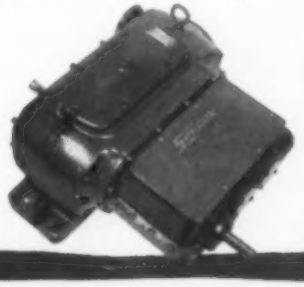

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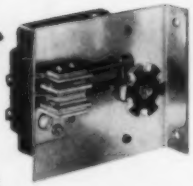
lights a sign... clangs a bell!



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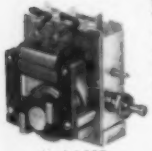

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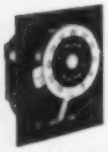

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localized buckling or nonelastic deformation—particularly when caused by inadequate dimensional stability or resistance to vibration effects; (3) designing only with plate, bar or shaped stock instead of employing composite approaches, involving castings, forgings, pressings.

Suggestions are given on avoiding excessive welding costs, determining minimum distance between joints, calculating design factors at bends, comparison of labor costs for certain processes. Vibration damping, buckling problems, joint design are also discussed.

"Design for Production by Welding," John Mikulak, Worthington Corp; Welding Journal, Sept '58, 29 W 39th St, New York 18.

Sensory Examination of Greases

How color, appearance, texture, odor can be and are used to evaluate lubricating greases. Limitations of such methods of observation are discussed and a vocabulary of standard terms proposed.

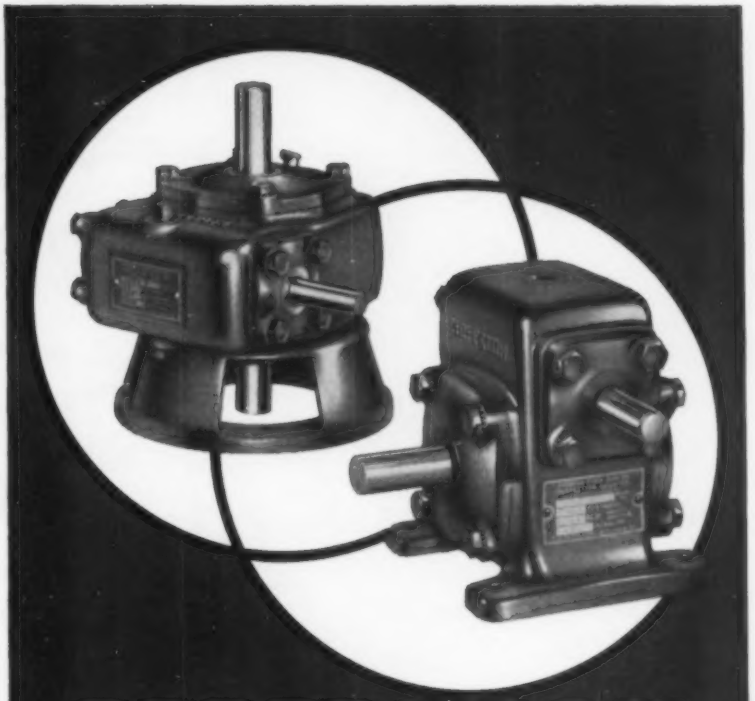
"Sensory Examination of Lubricating Greases," A. S. Orr, Gulf Oil Corp; NLGI Spokesman, Aug '58, 4638 J C Nichols Pkwy, Kansas City 12, Mo.

How to Read Heat Transfer in Russian

Exchange of technical information through the literature has led to adoption of common words in many languages, one of which is Russian. Keys given to pronouncing Russian alphabet make it possible to understand many of terms used. A vocabulary of commonly used words too ancient to have recognizable English equivalents is given.

"How to Read Heat Transfer in Russian," Mrs. F. F. Buckland, General Electric Co; Mechanical Engineering, Sept '58, 29 W 39th St, New York 18.

"And who told you to draw the plans in 3-D?"



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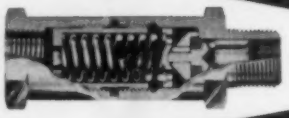

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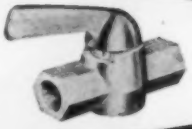

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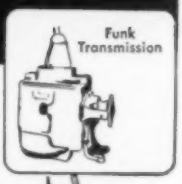

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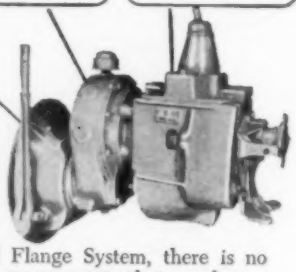

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NEW BOOKS

Living with the Sun

Published by Assn for Applied Solar Energy, 3424 N Central Ave, Phoenix, Ariz, 78 pp, 14½ x 14½. $6.

Sixty of the plans for solar-heated residences submitted to the 1957 International Architectural Competition sponsored by the Assn for Applied Solar Energy are included in this volume. Descriptions and the jury's analyses of the entries are given, as well as a summary of the technical aspects of solar heating. A bibliography is also included.

Atomic Energy Industry

Congressional Joint Committee on Atomic Energy, US Government Printing Office, 6x9, 625 pp. $1.75.

Where do we stand on atomic power? How many engineers will the atomic energy industry need? Who are the primary contractors for reactors now under construction? Answers to all these questions are found in this report from the Congressional Joint Committee on Atomic Energy. It contains a transcript of hearings held last February and March, plus a good many added reports; can provide useful background for those who wish to delve deeper into specific aspects of the power program. For over-all status of this program, see PE—Apr 14, p 52). The volume, as now prepared, has only a rudimentary index; but a separate index volume, to be issued later, should make the facts fairly easy to find.

Notes on Analog-Digital Conversion Techniques

EDITED BY ALFRED K. SUSSKIND. *Published by Technology Press of Massachusetts Institute of Technology and John Wiley & Sons, Inc, N. Y. 6x9, 500 pp. $10.*

The book is fundamentally a treatise on computers, and treats the subject as a series of concepts in computation rather than as a discussion of physical machines. The introduction (13 pages) is a clear description of basic information-processing functions needed to handle complex data. The

(Continued on page 149)

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This flea-like component for an electronic tube socket was all that stood between the manufacturer and a good-sized contract. Before acceptance, however, the part had to undergo a rigorous manual test prescribed by the Army Signal Corps, *and none of the metals tried by the manufacturer would measure up!*

Miller technical people went to work to find the answer, and in short order they developed a specially-treated phosphor bronze alloy that enabled the manufacturer to pass the test with flying colors! It combined rigidly controlled grain size, elongation in excess of 10% and still retained a remarkable tensile strength of 100,000 pounds per square inch!

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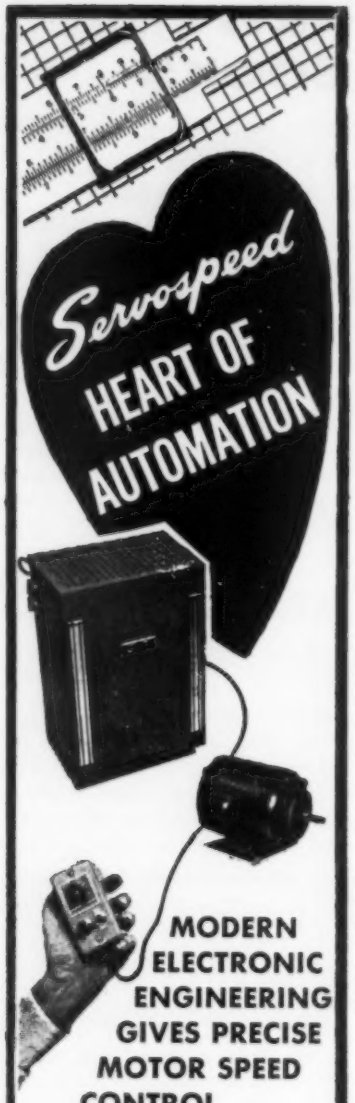

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computer, with its supplementary coding and decoding equipment, is obviously a necessity. This introduction creates a mental image of what any computer must be.

Because most data fed to computers is analog (constantly varying, as opposed to point-by-point), the remainder of the book describes techniques needed to "sample" this continuous data, code it in the form of discrete points for the computer, and finally decode it for the ultimate use of the human (or automatic) operator. Included are sampling and quantizing, and conversion between numerical systems such as position, octal, binary and decimal. Discussed are logic circuits, flip-flops, magnetic shift registers, cascading.

A detailed engineering analysis and evaluation of a variety of conversion devices is presented. These include electronic, magnetic, mechanical, electric, optical, and photographic.

The book, intended for newcomers to the field, is the result of a series of special summer programs (and the resulting papers) at M.I.T.

A Practical Guide to Design of Steel Castings

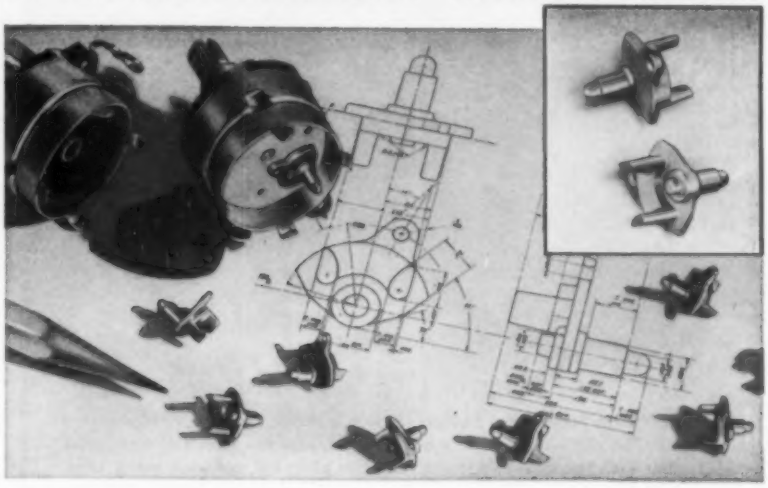
British Steel Castings Research Assn. Distributed by Penton Publishing Co, Penton Building, Cleveland 13. 52 pp, 8x10¼. 12/6d.

Cast steel combines high strength with ductility, but of all commercial material, it is most difficult to cast.

(Continued on page 151)

"There's been so many design changes on this product that even the 'yes' men around here aren't sure anymore."

ACCURACY OF TINY GRC DIE CAST PART AIDS MALLORY SWITCH DESIGN



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In a series of designs that started with a stamping and a screw machine piece involving multiple part assembly, Mallory engineers sought an actuating mechanism for a switch that would be capable of higher rating, longer life and greater dependability than switches using current-carrying springs. Such a control would require exceptional tolerances and critical dimensions to function properly. Uniformity would have to be assured as some of the contours couldn't be subjected to normal inspection procedures.

They found the answer in Gries' exclusive patented methods for the precise automatic production of tiny parts, and literally designed the switch around the GRC die casting.

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For more information ask for the GRC bulletins on small zinc alloy die castings and molded plastic parts or send prints for immediate quotations. Maximum sizes 1¾" long, ½ oz. in zinc alloy; 1¼" long, 03 oz. in plastic. No size too small.

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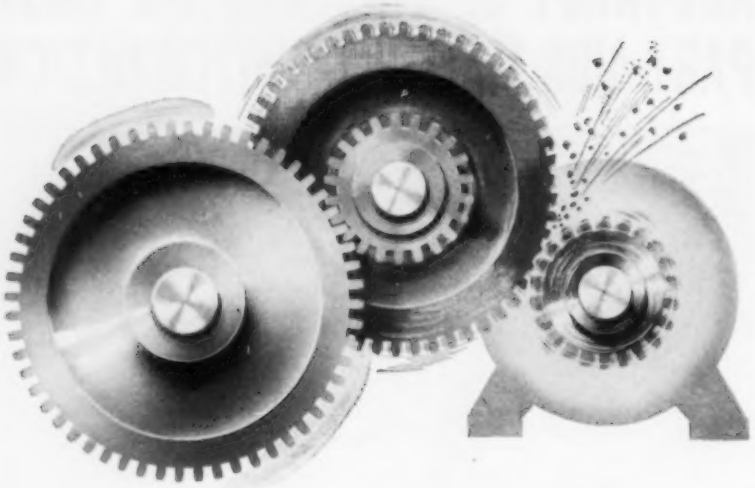


Protect Gear Trains and Equipment with a gear made of Taylor Laminated Plastic. This unit will act as a *safety valve*, localize the effects of destructive forces. Yet, under normal conditions, the gear will outwear metal ones.

Put a safety valve in your gear train

A gear made of Taylor Laminated Plastic Silent Gear Stock will localize damage due to destructive stresses, yet outwear metal under normal operating conditions

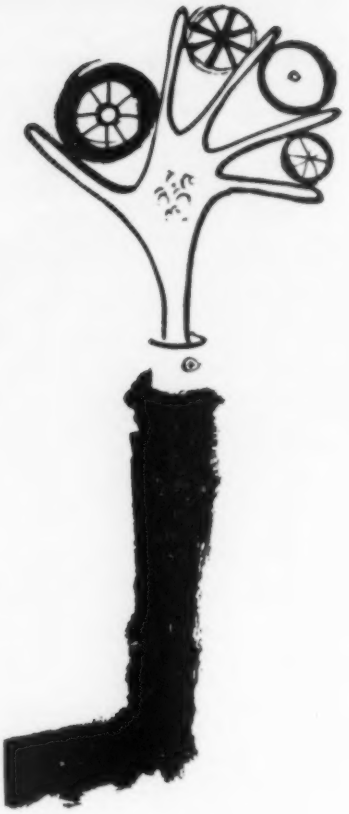
What gives when gears jam—the power train, the equipment they are in, or a single easy-to-replace gear? It can be the single gear when you install one made of Taylor Laminated Plastic Silent Gear Stock as a *safety valve*. This gear will localize the destructive forces and can even disintegrate—but the other gears in the train, and the equipment, will be fully protected. Yet under normal operating conditions this laminated plastic gear will outwear the metal ones.

Taylor Laminated Plastic Silent Gear Stock is made in several grades. Each has physical and mechanical properties that make it particularly adaptable to such application as gears, cams, pulleys, pinions, flat springs, and bearings.

Look into the advantages of Taylor Fibre Co. and its facilities for producing laminated plastics in mechanical, electrical and combination grades and parts fabricated from them. At your disposal will be engineering assistance and the convenience of integrated operations at both plants—Norristown, Pa., and La Verne, Calif. Contact TAYLOR FIBRE CO., Norristown 39, Pa., for complete information.

Taylor

LAMINATED PLASTICS VULCANIZED FIBRE



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Call him at Quincy for the quickest answers and the fastest follow-through in the wheel industry. He knows your product and his product, and how to put them together at competitive prices.

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Guided Missiles, Operations, Design and Theory

Sponsored by the Dept of Air Force. Published by McGraw-Hill Book Co, 330 W 42nd St, New York 36. 8½x11, 575 pp. $8.

Profusely illustrated, this is an excellent primer for operational personnel or anyone who requires a general working knowledge of missiles and their supporting equipment. Initially prepared for training courses by Air Training Command it is now an official Air Force Manual. This book should prove valuable for training technicians and production or test personnel working with missiles. Missile topics include: history, aerodynamics propulsion, physics, system components, control systems, guidance systems, tactics and instrumentation.

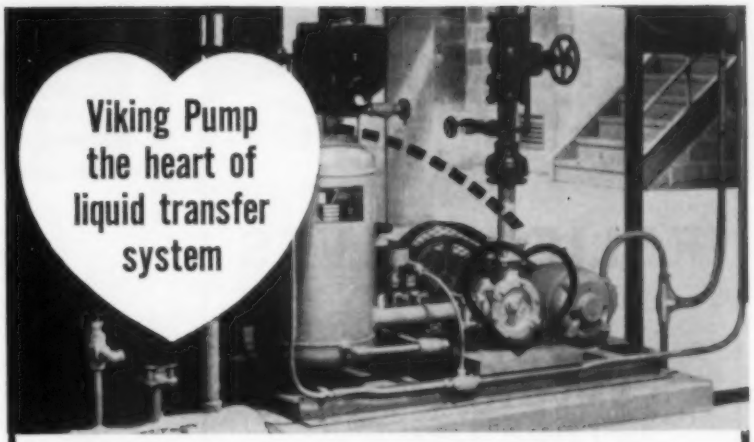
Graphic Science

THOMAS E. FRENCH *and* CHARLES J. VIERCK. *Published by McGraw-Hill Book Co, 330 W 42nd St, New York 36. 8x10, 758 pp. $8.50.*

This book combines subjects of engineering drawing, descriptive geometry, and graphics. Emphasis is on

(Continued on page 153)

"Wanna trade . . .?"



"Slugging," the bugaboo of refrigeration systems, was solved by The Vilter Manufacturing Company of Milwaukee, Wis., by a patented liquid transfer system for dairy and ice cream plant installation as well as for many other industries. A heavy duty, mechanically sealed Viking pump built to Vilter specifications was made the heart of the liquid transfer system. With electronic controls and solenoid valves, the pump removes liquid before it reaches the compressor.

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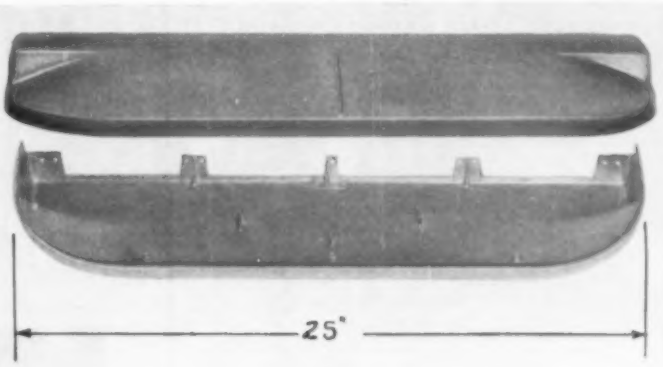

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- SMOOTH OPERATION
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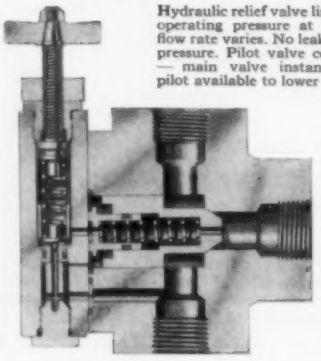
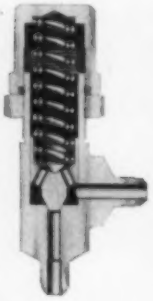


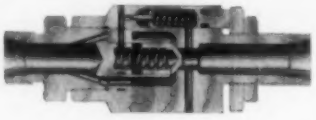
Hydraulic relief valve limits system's maximum operating pressure at constant level, though flow rate varies. No leakage loss below cracking pressure. Pilot valve controls pressure setting — main valve instantly conforms. Remote pilot available to lower setting of integral pilot control. 3 pressure ranges: 50 to 1200 psi; 1000 to 3000 psi; 2500 to 5000 psi. 50,000 tensile semi-steel body standard aluminum alloy to order. FMP or str. thread gasket seal bosses, ¼" to 1¼". Panel mounting bosses.

Modified units available as Sequence Operating Valves; and as Unloading Valves for clamping or other two-pressure applications.

POPPET TYPE RELIEF VALVE

Smoothly sliding poppet, seated by a stainless steel compression spring is the simple design of this rugged unit. External adjustment. Two types of sealing elements available. Soft seal poppets for air, gas, and liquids, with no leakage; stainless steel poppet for general hydraulic applications. Other poppet materials available for special chemical services. Eleven pressure ranges to 2750 psi, ⅛" to ¾" pipe, tubing, internal straight threading. 250°F std — specials to 400°F. Aluminum alloy, brass, or stainless steel.





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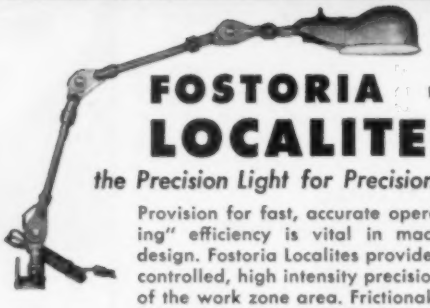

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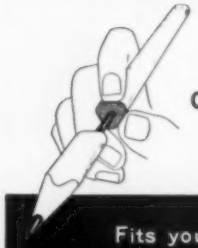

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CIRCLE 226 READER SERVICE CARD

graphics as a scientific engineering tool rather than an art. The authors' aim is to help the engineer become more competent in specifying graphic procedures in engineering work.

Subjects such as jigs and fixtures, gears and cams, architectural and structural drawings have been replaced with a complete coverage of descriptive geometry. Also covered are vector geometry, graphical solutions, functional scales, nomography, empirical equations and calculus.

Mathematical Tables and Formulas

F. J. CAMM, 5½x7½, 144 pp. hardbound. Published by Philosophical Library, 15 E 40th St, New York. $1.75.

Elementary tables and formulas, such as are found in pocket-size memo books, are reproduced here. Among them: tables of square and cube roots, weights of various substances, electrical equations. The material is basic, but has not been brought up to date. (The newer metals, for instance, are missing from the weight tables.) However, the book does have the advantage of bringing all of these standard items into one compendium.

Yearbook of American Bureau of Metal Statistics

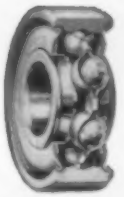
Compiled by American Bureau of Metal Statistics. Published by ABMS, 50 Broadway, New York 4. 8¼ x 10¾, 136 pp. $4.50 hardbound, $4 softbound.

Latest edition of this annual is now off the press, containing final figures for 1957 and previous years on nonferrous metal production and consumption, plus standard specifications and other data.

"I don't suppose the manager is in?"

Don't pay for precision you don't need

RMB Filmoseal Bearings available in low-cost ABEC-1 as well as ABEC-5 tolerances.



Big news in the miniature bearing field! RMB's famous Filmoseal Bearings—the only sealed miniature bearings—are now made to low-cost ABEC-1 as well as ABEC-5 tolerances. This means designers can use these advanced design bearings even in those slightly less demanding applications where cost is a primary consideration. Designers can take advantage of such features as:

1. Stainless-steel construction *throughout.*
2. Lubricant retention at *high temperatures.*
3. Non-contaminating *at all times.*
4. Two-piece ball separators for *high speeds.*

Open radial Conrad-type bearings are also available in this new grade. A wide range of sizes is available from 3/16" (0.1875") to ½" (.5000") OD including many metric sizes.

Write for your copy of the new RMB Miniature Bearings Catalog which gives full details on these as well as the entire line of quality RMB Bearings. Ask for Bulletin 62.

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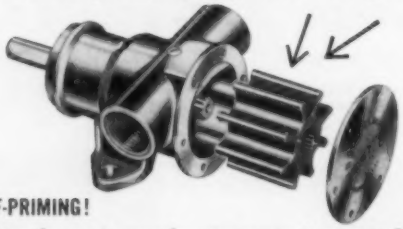

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- **Only one moving part**
- **Easy service without removal from the installation**
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CIRCLE 231 READER SERVICE CARD

Current Reprints

While the supply lasts, single copies of the following reprints are obtainable by using the Reader Service Card.

Optical Projectors

How projectors may be used in development, research and laboratory testing. Chart gives limitation and advantages of 30 conditions. Design Digest '58. *Circle E 44*

Three New Rigid Thermoplastics

Delrin, Lexan and Pro-fax are compared, with curves and tables. Sept. 29, '58. *Circle E 43*

Magnetic-force Welding

New welding method for vinyl-clad steel, with data on strengths and arrangements. Sept. 15, '58. *Circle E 42*

Electroluminescence

Roundup on this new area-source of light which needs no filament, arcing or activating rays. Sept. 15, '58. *Circle E 41*

Engineering in Europe

Editor Tangerman's report on engineering and design uncovered during his European trip. Sept. 1, '58. *Circle E 40*

Selecting Polyphase Motors

Tables match drive-load characteristics with motor designs in terms of torque slip and duty cycle. Aug. 18, '58. *Circle E 39*

Backlash in Spring Clutches

How two spring modifications can control backlash. Aug. 18, '58. *Circle E 38*

Swivel Joints

Guide for choosing swivels and other flexible hose-type connections. Aug. 4, '58. *Circle E 37*

Torque-limiting Devices

Analysis of 17 new and conventional ways to prevent motor overloading. Aug. 4, '58. *Circle E 36*

Heavy Metal

How high-density alloys may be used to solve design problems involving space and balancing. July 21, '58. *Circle E 33*

Stresses in Adhesive Joints

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Of Product Engineering published weekly with add'l issue in mid-Sept., at Albany, N. Y., for October 1, 1958.

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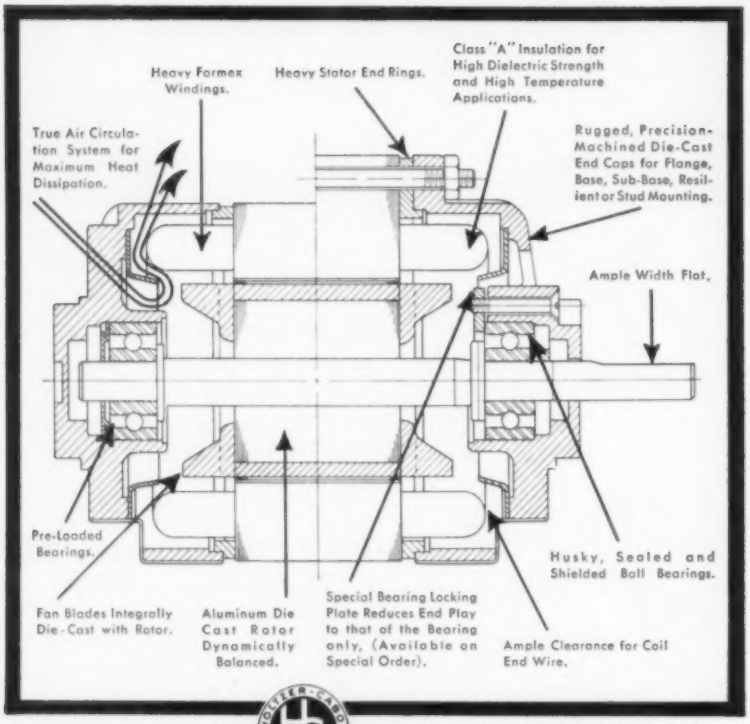
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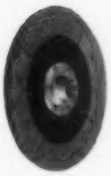

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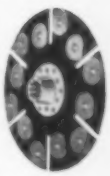

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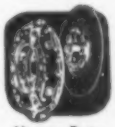

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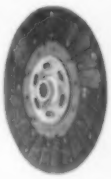

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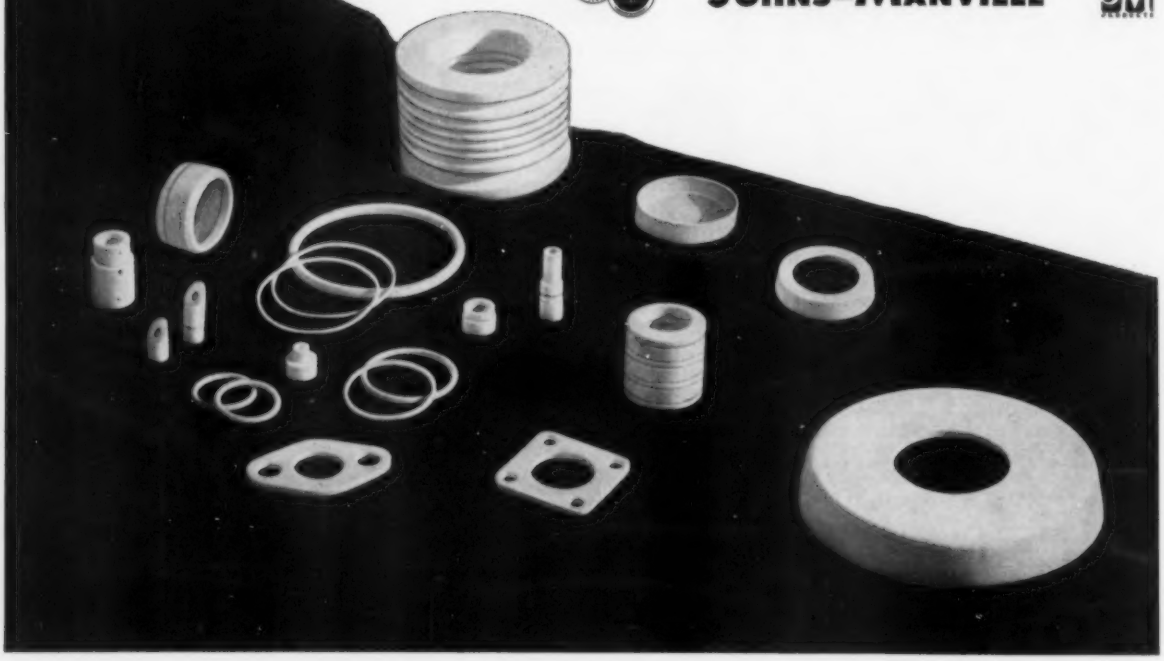

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E36. Torque-limiting Devices—Analysis of 17 new and conventional ways to prevent motor overloading and strain on equipment (8/4/58)

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ELECTRICAL, ELECTRONIC COMPONENTS

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48—Oil-filled Potentiometers, 7 pp, Helipot Div, Beckman Instruments.
62—Wire Bundling, 4 pp, Electrovert.
51—Transistor-equipped Time Delay Relays, 2 pp, Temp Instrument, Inc.
64—Subminiature Indicator Lights, 4 pp, Sloan Co.
60—Semiconductor Products, 4 pp, Hughes Products, Hughes Aircraft Co.
56—High-power Ac Solennoids, 4 pp, B/W Controller Corp.
50—Miniature Delay Lines, 2 pp, Columbia Technical Corp.
58—Minature Selector Switch, 2 pp, G H Leland, Inc.
59—Dual Preset Counter-Controllers, 4 pp, Computer Measurements Corp.
43—Level Controller, 4 pp, Robertshaw-Fulton Controls Co.
55—Aircraft Rotary Actuators, 4 pp, Airborne Accessories Corp.
36—Relays, 20 pp, Magnecraft Electric Co.
37—Metal-clad Switchgear, 40 pp, General Electric Co.

HYDRAULIC, PNEUMATIC EQUIPMENT

49—Valves for Instrument Piping, 4 pp, Jerguson Gage & Valve Co.
57—Flow Switch, 4 pp, McDonnell & Miller, Inc.
61—Variable Displacement Gear Pump, 4 pp, Pesco Div, Borg-Warner Corp.
33—Compression Packings, 20 pp, E F Houghton & Co.

E38

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REPRINTS
E31 E32 E33 E35 E36 E37 E38
E39 E40 E41 E42 E43 E44

* Item No.	PRODUCT

1	13	25	37	49	61	73	85	97	109	121	133	145	157	169	181	193	205	217	229	241	253	265	277
2	14	26	38	50	62	74	86	98	110	122	134	146	158	170	182	194	206	218	230	242	254	266	278
3	15	27	39	51	63	75	87	99	111	123	135	147	159	171	183	195	207	219	231	243	255	267	279
4	16	28	40	52	64	76	88	100	112	124	136	148	160	172	184	196	208	220	232	244	256	268	280
5	17	29	41	53	65	77	89	101	113	125	137	149	161	173	185	197	209	221	233	245	257	269	281
6	18	30	42	54	66	78	90	102	114	126	138	150	162	174	186	198	210	222	234	246	258	270	282
7	19	31	43	55	67	79	91	103	115	127	139	151	163	175	187	199	211	223	235	247	259	271	283
8	20	32	44	56	68	80	92	104	116	128	140	152	164	176	188	200	212	224	236	248	260	272	284
9	21	33	45	57	69	81	93	105	117	129	141	153	165	177	189	201	213	225	237	249	261	273	285
10	22	34	46	58	70	82	94	106	118	130	142	154	166	178	190	202	214	226	238	250	262	274	286
11	23	35	47	59	71	83	95	107	119	131	143	155	167	179	191	203	215	227	239	251	263	275	287
12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240	252	264	276	288

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8	20	32	44	56	68	80	92	104	116	128	140	152	164	176	188	200	212	224	236	248	260	272	284
9	21	33	45	57	69	81	93	105	117	129	141	153	165	177	189	201	213	225	237	249	261	273	285
10	22	34	46	58	70	82	94	106	118	130	142	154	166	178	190	202	214	226	238	250	262	274	286
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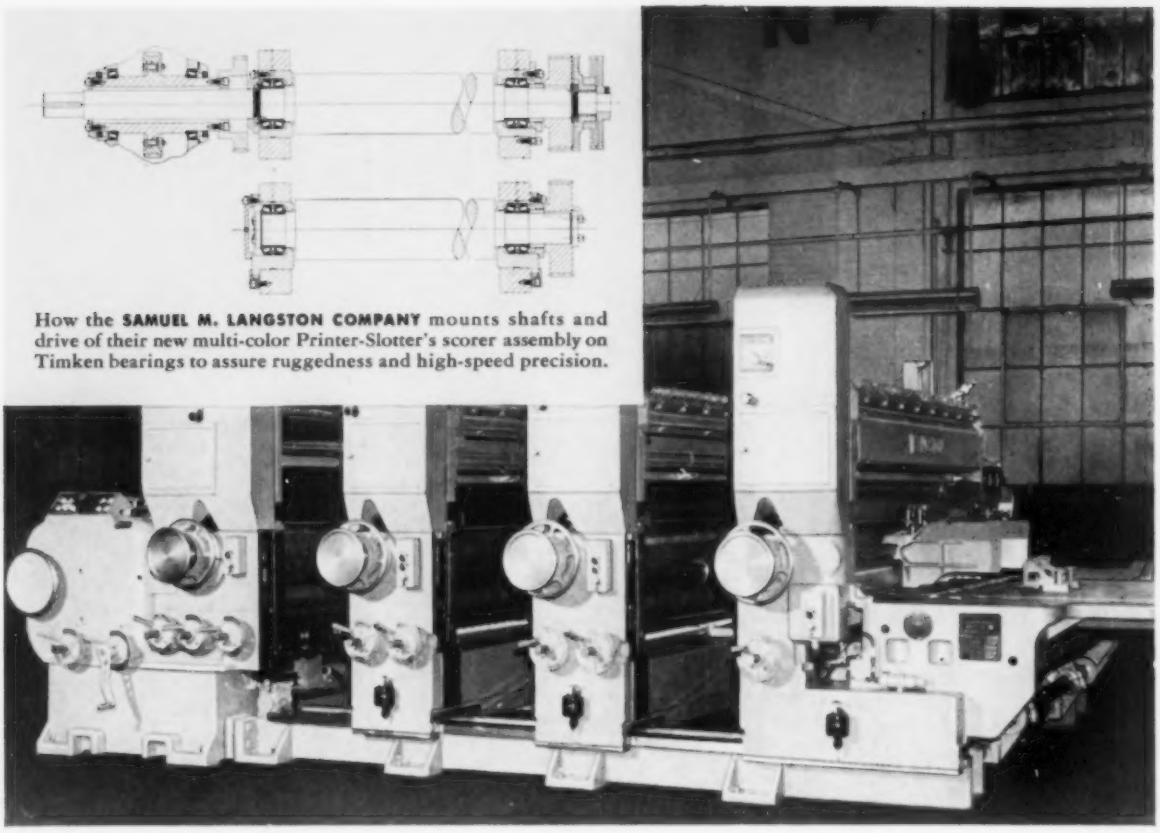
DIVISION OF RELIANCE ELECTRIC AND ENGINEERING CO.

How the **SAMUEL M. LANGSTON COMPANY** mounts shafts and drive of their new multi-color Printer-Slotter's scorer assembly on Timken bearings to assure ruggedness and high-speed precision.



No end play, no backlash—Langston printer-slotter gives lasting precision with Timken® bearings

THE Samuel M. Langston Company designed this new *Multi-Color Printer-Slotter* to print, slot and score corrugated paperboard at high speeds. It is built for maximum precision with minimum maintenance and downtime. Langston uses 76 Timken® tapered roller bearings to insure both ruggedness and precision. These Timken bearings stop end play by holding shafts and feed rolls rigid, take the heavy shock loads. And the adjustable Timken bearings on the drive help eliminate backlash. Here's how:

SHAFTS HELD RIGID. Their tapered design lets Timken bearings take radial *and* thrust loads in any combination. No end play to adversely affect accurate register, printing, slotting and scoring. Timken bearings hold shafts concentric with their housings, making seals more effective in keeping lubricant in—dirt out.

HEAVY SHOCKS ABSORBED. Both rollers and races are case-carburized to give Timken bearings hard, wear-resistant surfaces over tough, shock-resistant cores. Full-line contact between rollers and races gives load-carrying capacity to spare.

Timken bearings are geometrically designed to roll true, precision-made from our own Timken fine alloy, electric furnace steel to live up to their design. They practically eliminate friction, run smoother, last longer.

Why not get all these advantages for machines you buy or build? To make sure you do, specify bearings trade-marked "TIMKEN". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

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